DISCOVERY

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. EVANS, M.A., Ph.D.

Richard regory, F.R.S.
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F. J. NORTH, D.Sc., F.G.S.

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D. HAY SURGEONER, A.F.R.,Ae.S.

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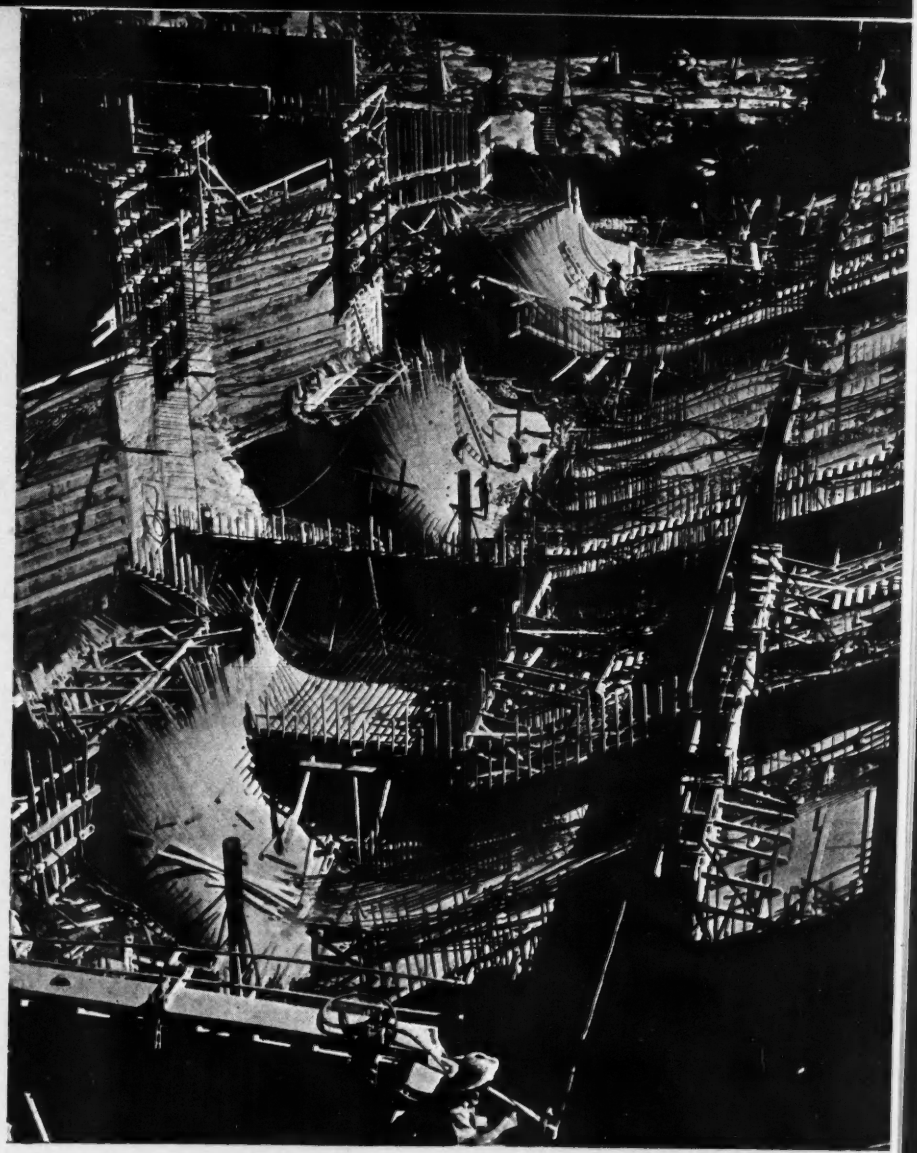

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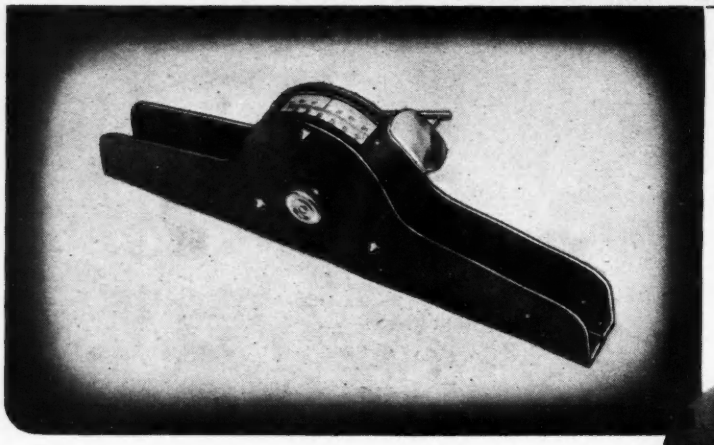

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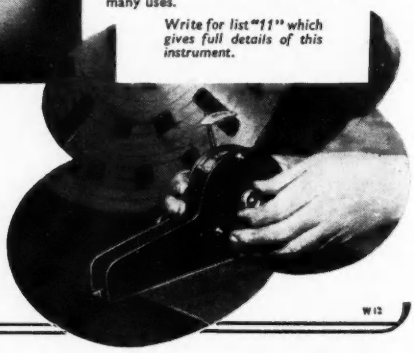

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DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

July 1943 Vol. IV No. 7 PUBLISHED AT THE EMPIRE PRESS, NORWICH, ENGLAND Tel. 21441

The Progress of Science

A MONTHLY NOTEBOOK COMPILED UNDER THE DIRECTION OF DAVID S. EVANS

Education for a Modern World

In the midst of the urgent tasks of to-day we are rightly beginning to discuss the problems of reconstruction, and without diminishing our present efforts are seeking to ensure that the arrival of peace will not catch us unprepared for the immense tasks which await us.

The reconstruction which will be undertaken must not be a temporary process to be followed by a new regression. It must be a continuous process of development towards a worthwhile society. In that process education of both our young people and our adults is an essential factor. We must realize that we can win or lose our future. in our schools and colleges, for in them the citizens of the future are being created, and on them will devolve the task of choosing the rulers and administrators who will mould the new world.

The task which will lie before us is the construction of a free and democratic society exempt from want and insecurity. In that society education must be essentially democratic. The portals of our educational institutions must be wide open to ability, and to ability alone. The war has taught us this lesson, and we must not forget it when peace comes. To-day there is a great need for men and women trained in special subjects, usually scientific and it has been recognized that to meet this need no barrier of poverty or social distinction must be allowed to stand in the way. To-day the student is paid to develop himself into a national asset, and it is recognized that in doing this he is rendering his due meed of service to the community.

This same principle must be continued after the war. Then—perhaps even more than now—we shall need technically trained personnel. We shall need their skill and knowledge and their youth and enthusiasm for the task before them, and we dare not return to a system in which education can be purchased, any more than we dare make access to an adequate medical service dependent on wealth.

But these technical experts are only the shock-troops Democracy needs better educated citizens far more numerous than the University minority. The slave states of the ancient world built the limited democracy of the ruling minority on the harsh labour of the workers. The modern world has mechanical slaves, which by their tireless labour can bring richness and an adequate standard of life to all citizens without exception. In a world making full use of the progress of applied science, poverty will be out of date; but to manage such a world successfully all its citizens must have some understanding of the foundations of their world. They can only secure and maintain a world of adequate food, clothing, and housing, and gain and keep their freedom from the insecurity and fear which has from the cradle to the grave been the lot of the vast majority of the population of every civilization of the past, if they are awake and alive to the possibilities of the new world, and if they can forestall any attempt to misuse their heritage.

In such a world education must have a core of scientific knowledge, and it can only be built by citizens who possess this knowledge. To-day the man who is ignorant of science is blind and deaf in a world of wonders. Far too many of our people are in this state of unawareness. To them science means the mere technical apparatus of scientific thinking : the symbols of mathematics, or chemistry, the long words understood only by the initiated. On the contrary, scientific knowledge and the methods of scientific thinking, which are already implicit in our laws and our literature. are rapidly developing into a way of life and a philosophy in tune with the world of to-day and to-morrow. They are emancipating mankind from the necessity of bondage to natural forces, as they have already freed him from superstition and fear of the unknown.

The attitude of the majority of students is derived from mistakes in our existing educational system. Such science as is taught is still dominated by the academic approach. All too often school science is taught as if all the pupils were to become research workers. They are taught the fundamental principles of science in a way which obscures the fact that these principles and laws have been refined—

often over the course of decades—by the finest intellects of their period, who have at last come to realize the necessity for particular refinements of presentation and statement. The pupil misses the whole significance of these principles, he fails to understand why hair-splitting accuracy is sometimes necessary and, becoming indifferent or hostile, he leaves school untouched by the greatest social phenomenon of our time.

It does not matter whether the citizen understands Newton's laws; but it is vitally important that he should realize that behind the maze of visible phenomena there are laws, which, once discovered, give man tremendous control over his environment. The pupil can be brought to realize the necessity for endeavouring to disentangle the selaws only by being brought up against this situation himself. We are in urgent need of a school science course designed as an aid to citizenship, in which instruction proceeds from the familiar but complex phenomena of our world to the laws which underly them. One familiar example is provided by the Emergency Blood Transfusion Service. The idea of replacing lost blood is an easy one to understand. To demonstrate that this idea cannot be applied without loss of life unless we study blood groups is a demonstration in one particular case that we cannot get far without a knowledge of the underlying laws of nature. Such examples are all around us; and if our future citizens are educated in this realistic fashion, we shall build up a nation really able to take advantage of modern scientific knowledge.

The same principle can be carried into our Universities. "Culture" is no longer the exclusive preserve of the humanities or the classics. Instruction in neither of these alone suffices to produce either a fully educated man or one capable of becoming an administrator. In both the Civil Service and in Parliament we have had many demonstrations of the fact that a knowledge of the classics, or even of modern politics and economics, is an insufficient preparation for the technical tasks of modern government. The war has brought some changes, and we owe a great debt of gratitude for the work of our scientists who played their part in our salvation; but there is always the danger that, after the war, we may slip back into the old bad ways, and try to our cost to dispense with the services of the scientist.

If our Universities are to remain the nurseries of administrators and statesmen they must supply an education in tune with modern needs. What better preparation could there be than a study of modern history, politics and economics coupled with a general science course, not of the usual type, but especially designed to exhibit the role which applied science plays and might play in the modern community?

Windows for X-Rays

THE progress of pure science has often been accelerated by advances in practical technique, or held up for lack of an essential device. An excellent example of this is afforded by the technical problems of making exit windows for X-ray tubes which shall be strong enough mechanically to allow of the maintenance of a high vacuum inside the tube. This particular problem is discussed in a recent article by Brackney and Atlee, which describes the progress which has been made in the utilisation of the light metal beryllium for this purpose.

The transparency of the window is not a crucial requirement for industrial and clinical purposes, for here, in some cases, very large voltages up to 1,000 kilovolts have been used, which give so great an intensity of the very highly penetrating shorter X-rays that a considerable loss in passing through the exit window is neither here nor there. But in special applications of X-rays such as the study of crystals by X-ray diffraction it is important to get X-rays which are of a suitable wavelength. These X-rays are fairly strongly absorbed even by special types of glass such as Lindemann glass, which is specially compounded for this purpose from elements whose atomic weight, and hence absorption, is very low. These special wavelengths are produced by the use of particular metals in the targets of the X-ray tubes and are characteristic of those metals. Increase of the operating voltage above the usual range of from 10 to 50 kilovolts is liable seriously to damage the target, since there is a limit to the amount of energy which can be dissipated from the small spot on the target, approximating to a geometrical point, from which the X-rays come. Under these circumstances the transparency of the exit window from the X-ray tube may make all the difference between complete failure and a useful intensity in the wavelength needed.

One material which has been much used for these windows is cellophane, but this has very obvious mechanical disadvantages, and can only be used with X-ray tubes which can be continuously evacuated. A preferable alternative for the permanently evacuated commercial tube is aluminium foil, but this has the disadvantage that it melts at quite a low temperature, thus making effective evacuation of the X-ray tube difficult; and in any case no satisfactory method has been evolved for soldering aluminium. Optically, aluminium foil is not too bad. For practical thicknesses of the windows, aluminium is a good deal better than Lindemann glass; but is far less transparent than beryllium, which is in its turn appreciably more opaque than cellophane.

The advantages of beryllium as a combination of reasonable transparency with good mechanical properties are considerable. It has a high melting-point and is as hard as mild steel. In spite of a certain brittleness it can be machined to disks as thin as one-hundredth of an inch. It is quite stable under ordinary atmospheric conditions, its surface being protected by a thin layer of oxide. It is a good conductor, can be easily soldered, has a low absorption for X-rays, and can be manufactured in such a way as to make it quite impervious to gases.

These properties make it possible to evacuate the X-ray tubes very thoroughly at high temperatures, which results in a longer effective life for the tube. Its heat-resisting properties enable the designer of tubes with beryllium windows to put the focal spot very near the window at a distance which may be as little as an inch, and in this way greater intensity is secured because the beam has spread out very little by the time it reaches the crystal to be studied. Beryllium's transparency to the longer X-ray wavelengths opens up the possibility of using chromium or titanium targets, which have comparatively long characteristic wavelengths; and this in turn will enable the X-ray worker to study crystals with comparatively large spacings, and mole-

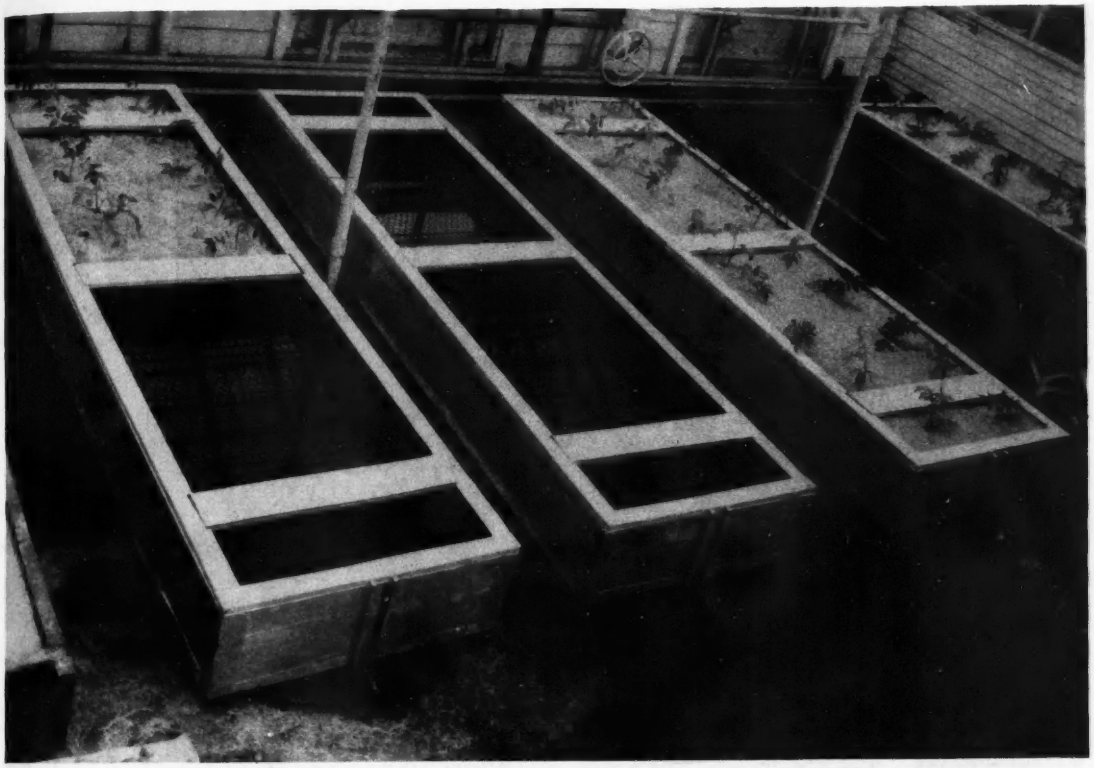

FIG. 1.—Tanks for growing plants by water culture, showing the general arrangement of tank equipment and the method of planting. Second tank from the left shows a frame supporting a wire screen fits over the metal tank filled with the nutrient solution. First tank on the left shows tomato plants are placed with their roots immersed in the nutrient solution. A layer of wood wool is spread over the netting, as shown in the far end of the tank. Third tank from the left shows the planting is completed by spreading a layer of rice hulls over the wood wool.

cules of greater size, such as for instance biologically important types of protein which have not yet been studied.

It is one of the most instructive features of the study of the history of science to see how each new technological advance finds its place as a tool of pure science, and opens up new fields of work which could not be entered before. The process is a reversible one, and we may expect from this advance to see the same phenomenon that we have witnessed before, namely a repayment of this debt by the further application of the new knowledge for which these technological advances opened the way. These new applications may be in very different branches of science—in the present case they may be in the biological field—but this flux and reflux of knowledge is a continuous demonstration of the essential unity of all branches of science.

Hydroponics

THE subject of hydroponics, or the technique of growing plants without soil, has received a considerable amount of publicity in recent years. Just before the war American scientists developed this technique to a commercial scale. By this means plants such as tomatoes, lettuces, cabbages, spinach and potatoes can be grown in pots or trays containing only a small amount of water in which are dissolved the mineral salts necessary for the nutrition of the plant.

The commercial application of the method has not been extensive, but one interesting example is provided by the case of Walne Island, a small American possession in the Pacific. It is a tiny rocky islet only half an acre in extent which was used as a stopping-place for the China Clipper on its route from Hong Kong to California. By installing a number of tanks for water culture, it was possible to grow supplies of fresh vegetables for the Clipper. In the ordinary way the crops are raised in greenhouses, but the sub-tropical climate of the island rendered this unnecessary, and the plants could be grown in the open.

For large-scale operations flat trays are filled with the nutrient solutions and are covered over with a layer of wire-netting, which is strewn with moss or fine shavings. This should be in contact with the solution, and if seeds are sprinkled on it, they will germinate and put down roots into the solution, thereafter growing in normal fashion.

To try the method out on a small scale is simple enough. Take a large jam-jar, put a rusty nail in the bottom to supply the iron content, and make up the three solutions that follow: Dissolve 25·5 grams of potassium acid-phosphate, 12·28 grams of calcium nitrate, and 16·98 grams of magnesium sulphate separately, each in half a litre of water, and keep the solutions in separate bottles. Put one and a half teaspoonfuls of each solution into the

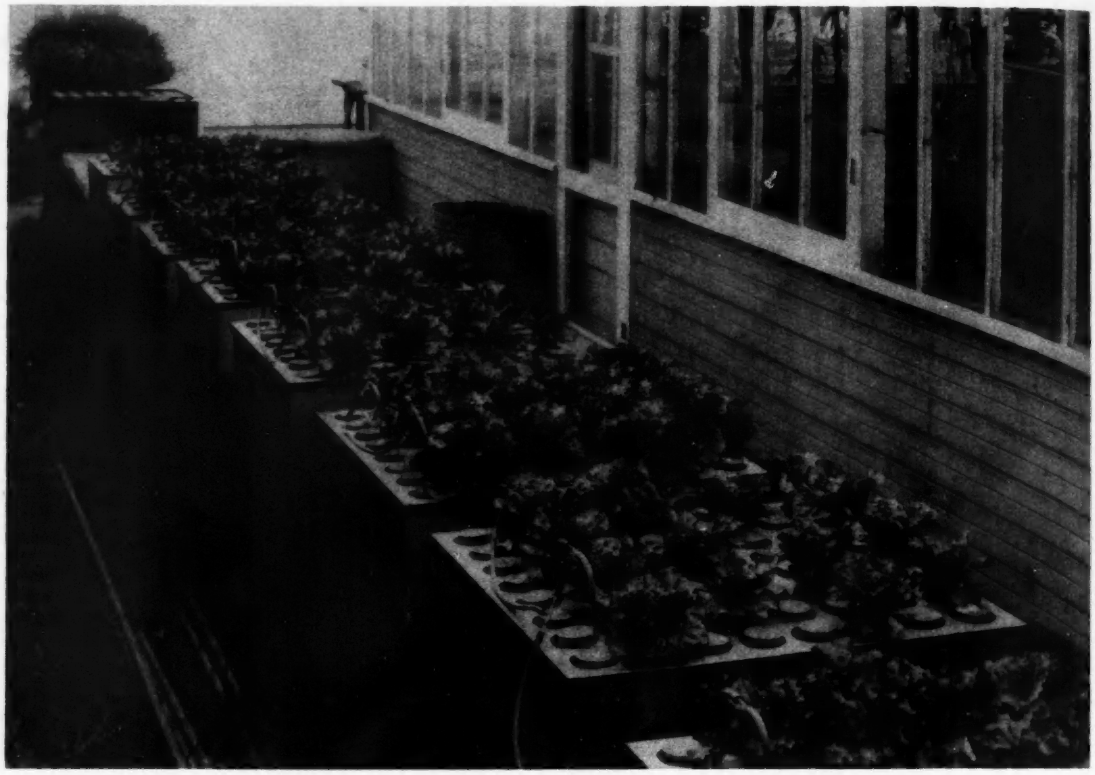

FIG 2.—This illustrates the use of water-culture technique for studying the nutritional responses of lettuce plants under controlled conditions. The individual plants are supported in corks which are placed in holes drilled in the metal covers. The glass and rubber tubes carry air under pressure which is bubbled, through the nutrient solution in the tanks.

jam-jar, and fill up with water. Cover the mouth of the jar with a piece of mosquito netting, allowing it to sag down into the solution.

When this has been done, sprinkle the seeds on the netting, and cover them with wet, clean blotting paper, which should be removed when the seeds have sprouted. During growth make sure that the water level always reaches the netting, and every two or three weeks add a teaspoonful of each of the nutrient solutions.

Waves and Particles

THE electron was discovered more than four decades ago by the late Sir J. J. Thomson. In the recent Birthday Honours appears the name of his son, Professor G. P. Thomson, who has been accorded the honour of knighthood. Professor Thomson is a distinguished physicist who has carried on his father's work, and whose great contribution to scientific thought has been his work on the dual nature of the electron.

The electron was at first believed to be simply a tiny elementary particle of negative electricity, but in 1928 Professor Thompson showed experimentally that a beam of electrons could be made to show diffraction effects similar to those exhibited by light waves. The same effect had been observed independently at about the same time by Davisson and Germer working in America, and later Thomson and Davisson were jointly awarded the Nobel Prize for Physics for this work. To-day the electron microscope, which uses this property of electrons, bids fair to become one of the most powerful new weapons of research in many fields of science, and has now been developed to such a stage of perfection that it can be produced commercially.

The other half of the picture is the modern discovery that light behaves in some ways as if it were a stream of particles, and it is interesting to note that this new development of particle optics coincides roughly with the tercentenary of Newton's birth. After being buried for nearly two centuries, Newton's corpuscular theory of light has been resurrected by the work of the twentieth-century physicists. Newton is usually remembered for his fundamental contributions to mathematics and the theory of gravitation, but he also put forward a corpuscular theory of light which remained in comparative obscurity because it was thought to be inconsistent with certain optical phenomena discovered after his time.

The first—astonishingly modern—theory of the nature of light was formulated by the Pythagoreans, who taught that light was a stream of small particles continu-

ally emitted from illuminated surfaces, and which on entering the eye produced the phenomena of vision. It was this theory which Newton elaborated, and which he tried to reconcile with the optical phenomena discovered by himself and his contemporaries. It is generally taught that such views were in opposition to the wave-theory propounded by Huyghens and Hooke, which considered light as vibrations of a hypothetical medium, the ether, which was supposed to pervade all space.

No such clear-cut division between the two theories can, however, be made; for Huyghens himself considered light rather as wavelets, which to a certain extent resemble the wave-packets of modern physics, while Newton was forced to ascribe wave properties to his particles to account for such phenomena as the refraction *and* reflection of light on the surface of transparent media. In addition it is not true, although it was so held in the nineteenth century, that the wave-theory of light could explain without difficulty such phenomena as refraction, interference, and polarization, for which the emission theory could only account by making a number of different assumptions. In fact, the wave-theory has to rely entirely on the hypothetical ether, to which it was forced to assign a number of very peculiar physical properties. The Michelson Morley experiment, carried out at the turn of the century, which showed that the speed of light was the same whatever the motion of the observer, dealt a mortal blow to the ether hypothesis, and with it of course to the simple wave-theory of light.

Doubts as to the conception of light as an even stream of waves came from another quarter. In 1900, Max Planck, in his endeavours to develop a theory of radiation from existing experimental material, came to the conclusion that all radiation, including light, exists in little packets, called quanta, which to some extent may be regarded as atoms of radiant energy. His ideas received strong support from observations of the photo-electric effect, which showed that electrons were only ejected from the surface of certain metals by light quanta possessing a sufficient energy, and that quanta of a lesser energy, no matter how numerous, had no effect.

All these considerations necessarily revived the Newtonian ideas, and modern theoretical physics in developing wave-mechanics no longer regards radiation and matter as consisting either as particles *or* waves, but ascribes to each a dual character which comprises the properties of both. This synthesis was described very aptly by the late Sir William Bragg in the words: "We teach the wave-theory on Mondays, Wednesdays and Fridays, and the corpuscular theory on Tuesdays, Thursdays and Saturdays."

Thus instead of speaking of light waves of one particular wavelength, we may with equal justification speak of photons, *i.e.* of light particles of a particular energy, and instead of discussing the motion of an electron as a material particle, we may discuss the propagation of the waves which are equivalent to such a corpuscular motion. These latter waves can be bent like the waves of light, not in glass or quartz lenses, but in electro-magnetic or electrostatic "lenses" specially designed for the purpose. Just as we can build a light microscope from a combination of ordinary lenses, so we can build an electron microscope from a combination of this new kind of lens. The dual nature of radiation and the wave properties of corpuscles were first fully appreciated by the French physicist, Louis de Broglie, and by the Austrian Erwin Schrödinger, now professor in Dublin, and the theory has been extended by the Englishman, Dirac, working at Cambridge. However, although it is now possible to give a satisfactory interpretations of many special phenomena by means of wave mechanics, these must be considered as only the foundations of a vast edifice which will eventually be built, in which the theory of matter and of electro-magnetic radiation will be brought into harmony.

One of the essential conditions for the development of such a unified theory will be to free it from models based on mechanical analogies, such as those which governed the development of nineteenth-century physics. The discovery of the dual nature of light and matter has made it clear to us that neither the conception of a wave nor that of a moving particle can do full justice to the phenomena of radiation, because both these concepts are mechanical ones based on our everyday experience of large-scale phenomena, and we must not expect either of them necessarily to have its counterpart in the world of atomic dimensions.

Storm

SCIENTIFIC romances we have had in plenty, but all too often they have been more romantic than scientific. There have been exceptions, such as for example some of the works of Mr. H. G. Wells, where the scientific prerequisites of even such improbable undertakings as voyages to other planets have been carefully worked out. There have even been cases where this process has been carried much further and where scientists have amused themselves by working out in detail the practical requirements of such adventures. The results have thus been controlled flights of fancy, at once entertaining and instructive.

However, Mr. George Stewart in his novel *Storm*, has gone one or two better than this, and in a book which will rank as a classic in the exposition of popular science, has produced a work which the scientist will not be able to put down until it is finished, and which, judging by its American sales of a quarter of a million, takes the general public in the same way.

To those scientists who have been concerned to secure a general popular appreciation of science this book will come as a revelation of a new technique which is sure to find its adherents elsewhere. Even the most ingenious of the expositors of popular science in this country have tended to stick to the principle that popular science should be the description of scientific work and its results rather along the lines of a scientific paper or a text-book provided with a greater wealth of explanation and attractive example.

Mr. Stewart throws all this overboard, and writes a novel distinguished for its admirable command of the English language in which the hero is neither man nor woman nor animal, but a meteorological disturbance. He takes us into a great variety of scientific institutions and shows us the scientists as human beings at work. He also succeeds in showing how all-pervading applied science is in our modern civilisation. He achieves the effects that many of us would like to have attained not by direct exposition, but incidentally, although none the less vividly and forcibly for all that.

His novel opens in a meteorological office on the West Coast of the United States, where a young and business-like scientist, lacking all eccentricity, and resembling the scientists we meet in our ordinary work, is plotting out his meteorological chart for the day. The hero, or rather the heroine, for the young meteorologist calls her Maria, is a small disturbance on the other side of the Pacific, and the novel is the record of her growth into a great and devastating storm as she moves westwards to the American continent. There we read how she blocks the highways and railroads with snow, floods the valleys and disorganizes the electricity supply, and all the time there is this almost uncanny scientific accuracy which runs like a golden thread throughout the book.

The author proves himself completely at home with, and able to expound in vivid detail, such meterological technicalities as warm fronts and cold fronts, cyclones and regions of high pressure. But the scientist will greet with a real feeling of satisfaction not only these larger topics but the correctness of the detail which describes the process by which a rotting log eventually rolls down a hillside, or the snow load which eventually breaks a copper cable in just the way in which the scientist has seen a copper cable break in the laboratory.

All too often the excellent film or the good story is spoiled for the scientist by a crashing technical error and it is a real treat to find in Mr. Stewart's book not only correctness of detail, but integration of those details into the theme of the story. In writing this book Mr. Stewart has opened a new field of popular science, and we shall be fortunate indeed in this country if we can produce authors who can match his superlative and effortless technique.

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Storm: George R. Stewart, Hutchinson.

COAL RESEARCH—*contd. from 209.*

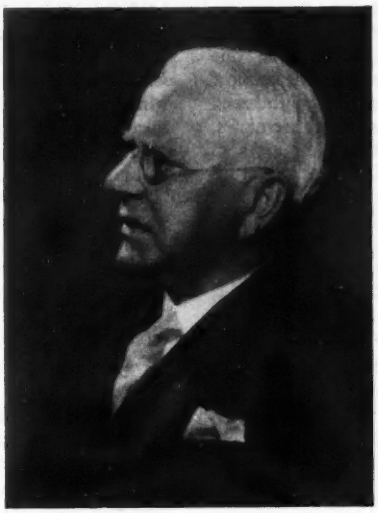
matter would obviously be useless for the preparation of town-gas or tar, while a highly "bituminous" coal, that is, one with much volatile matter, and a tendency to soften and cake together when heated owing to the liberation of tar, would not be suitable for use in a slow-combustion stove, which is intended to burn for long periods without attention and requires a fuel that remains in separate fragments until completely burnt away.

Coal as Heat Producer

The necessity for accurate knowledge concerning the kind of coal that is likely to be available, as well as information relating to any deviation from the original specification that may from time to time be expected, can also be illustrated by reference to a boiler plant in which the furnace is automatically fed, as, for example, by a "chain grate" stoker. This is an appliance in which the grate takes the form of a wide endless chain that travels across the bottom of the combustion chamber, curving under and returning after reaching the end, thus providing a grate that continually moves forward, carrying the fuel with it. The fuel falls on to the grate from a container at the front of the furnace, and if the rate of movement of the grate is correctly adjusted to the nature of the fuel that is being used, the latter should have been completely consumed when the traverse is completed, so that only the incombustible ash remains to be discharged at the back of the furnace.

A coal that burns relatively quickly would have to be supplied to such a grate more quickly than a slower burning coal, or the movement of the grate accelerated, otherwise the fuel might be completely consumed before it had travelled as far as it was intended to, and this would leave part of the grate without fuel and would allow air to pass directly towards the flues. Such air, in excess of that necessary to complete the combustion of the fuel, tends to cool the gases that come into contact with those parts of the boiler where heat is transmitted to the water within, and does not take part in the combustion and so help to increase the amount of available heat.

Other coal-burning appliances are similarly exacting in their demands, and other properties of coal than those associated with the nature and amount of the volatile constituents are involved. The proportion, distribution, and composition of the incombustible matter that will give rise to ash have to be considered, as well as the liability of the coal to disintegration and spontaneous combustion, but even this incomplete and generalized narration of facts relating to one aspect only of the utilisation of coal should help towards a realization of the necessity for further research, the principles upon which it will be based, and the lines along which it is likely to develop. What applies to coal as a source of heat and power applies with equal force, although in somewhat different ways, to its use as a raw material.



Sir Richard Gregory, F.R.S.

PRESIDENT OF THE BRITISH ASSOCIATION

MOST conference committees would hesitate before requesting H. G. Wells to cut short a paper which he had specially prepared for their meeting. Yet, briefly, that is what happened at the British Association's "Science and World Order" conference two years ago. Oddly enough Wells took it like a lamb, uttering no more than a few unWellsian words of formal protest. He might have taken a different line had the president of the British Association been other than Sir Richard Gregory. For the two men have been friends from the first time they met as fellow students of the Normal School of Science. As Sir Richard has written "We have been close companions ever since, with never an unkind word passing between us." All of which goes to show why the conference committee rushed in where others might have feared to tread!

When Wells and Gregory were at South Kensington the Normal School of Science (now the Royal College of Science) occupied the whole of the red brick building which to-day is known as the Huxley building and which faces the Science Museum. Both men, when they entered college, were rather older than the average run of students; Gregory was nearly twenty-two, and Wells, who is eighteen months younger than Gregory, had then just started on his second year. Before winning places as "teachers in training" at the Normal School, both had seen something of life. Wells had served in a draper's shop, Gregory had been an apprentice in a boot and shoe factory. Both Wells and Gregory gained entrance to the Normal School on the results of the May examination of the Science and Art Department, and were entitled to free tuition and a maintenance grant of a guinea a week, payable on the Wednesday of each week during term time. (The grant automatically stopped when vacations started.)

Sir Richard's earliest education demands the satirical Dickensian touch to do it justice. The conditions at the City School in Bristol, which he joined at the age of ten, resembled those of Dotheboy's Hall in *Nicholas Nickleby*. The masters ignored the fact that their pupils had been given names and addressed them by numbers, as though they were convicts; the present president of the British Association was thus expected to answer to the call of "Number 107"! He probably had few regrets when his schooldays ended and he started work at the age of twelve, delivering newspapers at a wage of four shillings and sixpence a week. Next we find his father, a cobbler by trade, but a poet and socialist by inclination (Sir Richard speaks with great pride of his father's qualities), apprenticing him to a boot factory. But cobbling was not to the boy's fancy, and it was not long before he had found himself a job as lab. assistant at Clifton College, where he came under the sympathetic eye of the late Prof. A. M. Worthington, a science master who had studied physics under Helmholtz in Berlin. It was his success in the May examinations of 1885 which took Sir Richard to the Normal School of Science in the January of the following year.

In those days the head of the school's biology department was Prof. T. H. Huxley. T. E. Thorpe (later Sir Edward Thorpe) was professor of chemistry, while Prof. Guthrie had charge of the physics department, in which Gregory spent a great part of his college days. In Wells's autobiography you will find a cameo of that physics course. "Guthrie, to put it bluntly, maundered amidst ill-marshalled facts. He never said a thing that wasn't to be found in a textbook, and his course of lectures had to be supplemented by his assistant professor, C. V. Boys, then an extremely blond and largely inaudible young man

already famous for his manipulative skill and ingenuity with soap bubbles, quartz fibres and measuring mechanisms." Guthrie placed particular emphasis upon one feature of science trading; all his students had to learn how to produce for themselves the apparatus they might need if they became science teachers. As Wells remarks, "Unaware of the economic forces that evoke supply in response to demand he decided that it was a matter of primary necessity that we should learn to make that apparatus for ourselves. Then, even upon desert islands or in savage jungles, we should not be at a loss if suddenly an evening class surrounded us . . . So instead of a student I became an amateur glass worker and carpenter."

Some students may well have found this training valuable in after life; as for instance F. W. Lanchester, of Lanchester-cars fame, who worked at the next bench to Gregory—within ten years of his leaving South Kensington Lanchester was to make history by designing the first petrol engine to be built in this country.

Gregory continued his work in physics for a year with Sir Arthur Rucker and obtained a first-class in final examinations. He almost certainly did not enjoy the physics curriculum, and we find that he took the first possible chance of leaving college; he did so without even completing his course and became assistant to Prof. A. M. Worthington at the excellent Dockyard School at Portsmouth.

The journalistic activities of Wells and Gregory while at college are worth a passing reference. Wells had started a magazine called the *Science Schools Journal*. Gregory, who had written for the Bristol papers before coming to London, used to write "chatty notes" which Wells would publish.

Joins *Nature*

Gregory returned to South Kensington, after a spell at the Dockyard School, to become personal assistant to Sir Norman Lockyer who, besides lecturing at the Normal School, was in charge of the Solar Physics Laboratory that stood on the site now occupied by the Science Museum. Before long we find Sir Richard devoting more and more time to writing, and giving university extension lectures, until he became able to give up his post under Lockyer and keep himself on his free-lance earnings. After two years as a free-lance he received a letter from Lockyer asking him to call. Some thirty years previously Lockyer had founded *Nature*, and now he found himself in need of a new assistant editor. He offered the post to Gregory, who accepted it without delay, to start his career with the paper with which he was to remain for forty-five years, and of which he was to become editor when Lockyer relinquished the editorship in 1919. During those years he saw over two thousand weekly issues of *Nature* through the press, and it would need a better arithmetician than myself to calculate the number of major scientific discoveries which Gregory must have read about in manuscript and in proof days, and even weeks, before the information was available to the scientists of the world. *Nature's* present lay-out and character are a measure of Sir Richard's skill in editing scientific copy; it was he who introduced the thought-provoking leaders and features like News and Views.

Perhaps the greatest compliment ever paid to him and the surest proof that his ideas on the editing of the world's most famous science paper were fundamentally sound was paid to him by the Nazis, those intellectual gorillas who claim with pride that the mention of the word "culture" makes them reach for the safety-catch of their revolvers. *Nature* was banned in 1935 by the German Minister of Education, and the paper joined the then select group of journals which Germans were forbidden to read. The reason for the ban was of course that *Nature* had condemned the Nazis' persecution of truth.

While he was editor of *Nature*, Sir Richard used to act as adviser on scientific textbooks to his publishers, Macmillans. He has many shrewd ideas about the type of books that teachers and students require. One example of a happy inspiration of his is "Duncan and Starling". It was his suggestion that an engineer and a physicist should be brought up together and produce a physics textbook: "Duncan and Starling" was the result.

President of the British Association

Sir Richard was elected president of the British Association in 1939, three days before war was declared. According to the Association's constitution he will remain president until the war ends, as a new president can be elected only by the annual meeting. His connection with the "British Ass" really dates back to the first time he covered an annual conference for *Nature*; that was fifty years ago, and he has since attended every meeting that has been held in Britain. When Section L, the Educational Section, was set up, he became its secretary, and a few years after, its President. This section, in its investigations of educational topics, has roamed far and wide; it has produced many useful reports covering subjects as diverse as "Science in Secondary Schools" and "The effect of textbooks on eyesight". Sir Richard is particularly interested in the work of the social relations division of the B.A., which is a large autonomous committee with the power to co-opt non-scientists as members. It is this committee which has kept the British Association alive during the war, so far as the public are concerned, by holding conferences on Science and World Order, Mineral Resources, and Science and Citizenship.

Sir Richard will be 80 next birthday (and, according to *Who's Who*, dancing is still one of his hobbies!) Over half of his life has been spent with *Nature*; he joined the staff in 1893, and retired in 1938. Those forty-five years brought him the friendship of many scientists, both senior and junior, and the respect of a great many more. As a scientific journalist he has few equals. His services to the scientific community in that capacity have been recognized by several universities which have conferred honorary degrees on him, and notably by the Royal Society which elected him an F.R.S. in 1933. He was knighted in 1919, and made a baronet in 1931.

It is appropriate to end this short article by mentioning that it was from Sir Richard's book *Discovery, or the Spirit and Service of Science* that the title of the journal you are reading was taken. It was the original publisher of *Discovery*, John Murray, who asked permission to use the name on the cover, and I think it may be fairly claimed that throughout its history the various editors of this paper have kept before them not merely the first word but the whole of Sir Richard's book-title.

WILLIAM E. DICK

PROBLEMS OF A
"Freedom from want" Economy

F. LE GROS CLARK

WHEN in February 1942 the British and American Governments signed the agreement on the principles of mutual aid in the war, a clause was inserted, touching upon the "provision for agreed action . . . directed to the expansion, by appropriate international and domestic measures, of production, employment and the exchange of consumption goods, which are the material foundations of the liberty and welfare of all peoples". The phrasing of this article of the agreement has a Transatlantic flavour about it, though one may doubt whether commercial opinion in America would, as a whole, subscribe to it. For the food scientist and the food economist, however, it is a piece of sound doctrine. One of the most impressive features of this war is the fact that so many public men seem now prepared to assume responsibility for the feeding, not of a single community alone, but of the whole population of the earth; and this trend of opinion has, at the time of writing, manifested itself in the Hot Springs Conference, which aims at the formulation of reports concerned with "agriculture's importance in meeting the essential needs of human life in such a way as to stimulate peace and progress" and with the augmentation of "the production of goods now scarce to many millions of people".

The two wars have marked the two stages in this process in human thought. In what we may—seeing that we have fallen into the American idiom—suitably term World War One, a few governments called upon their research workers to advise them as to the quantities and kinds of food required by a given population, if it were to maintain its fighting efficiency. Now, twenty-five years later, it is unofficially proposed that governments should use the period of post-war relief measures to investigate the actual food production and food requirements of the human race; and this with the intention that productivity shall be as soon as possible raised to the level of ascertained needs. One may here comment in passing that, if the League of Nations had done nothing else to justify its existence, it leaves the world in its debt for the determined way in which it gave human diets a *global* significance. The work of its mixed committee in the years 1935-38 slowly infected the scientist and the food economist with a universal view; and there are probably few of us now left who would restrict the business in hand to the confines of this or that national frontier.

How far has world food production fallen short of world food requirements? In our present state of knowledge it is not easy to give a precise answer; and we ought perhaps to venture at this stage on one or two qualifying remarks. The human race may, as a whole, have been underfed; but it has not died out. It still persists. True, there have been famines; and unless we change the direction of our policy there will presumably be more famines. According to one estimate the famines in India alone, and over the last quarter of the nineteenth century alone, resulted in a matter of 26,000,000 deaths. Similar estimates might be made for China and doubtless for other less populous regions. But unnecessary as this wastage of life may be, the race still survives and breeds; and surely we may now ask ourselves whether it is not so much the wastage of human life that concerns us, as the stunting and warping of the bodies and the minds of the countless millions who insist on surviving through it all. The fact is that most men do not biologically speaking become completely *men*; in the sense in which most rabbits, if the herbage is plentiful and they are spared a violent death, become completely and physiologically *rabbits*. Our admonition to the human race should surely run "Do be *yourself*, Homo Sapiens"; and we might add, seeing that Man has been long enough upon this earth to know better, "Homo Sapiens, *be your age*".

We have, then, to apply some kind of dietetic yardstick to Homo Sapiens, as represented by the living peoples of the globe. There is no escape from this. Man has to be measured for his food supply; and the measurement is expressed ultimately in terms of lowered vitality, sub-normal health, failing stamina, and the unnecessary contraction of the span of human life. More immediately the standards adopted must be such as reduce to a series of calculable units the actual needs of a human being in terms of muscular and skeletal growth, daily output of energy and so forth. This is not the place to discuss the scientific validity of these standards or how far they can be relied upon to convey a true picture of the state of affairs. One comment only need be made. It is sometimes objected that there are conflicting standards in existence, all expressed in terms of Calories, protein, vitamin requirements and so forth. The objection may be dismissed at once. The science of human nutrition is like every other science; as our methods of investigation are refined, so slight adjustments are made in the estimates in regard to this or that nutrient factor. The only trouble is that we have not yet agreed to standardize the standards. The League's technical commission, meeting late in 1935, took about a day to agree on its standards. It is obvious that an international revision of standards should be undertaken at intervals of, say, two years; and that the current table of standards should, in the interval, be accepted as the basis of all investigations of social groups.

So slight, however, is the disparity between the three or four dietetic standards that at present hold the field, that they may readily be reduced to a common measure; and in any case such terms as protein and mineral salts

have ultimately to be converted into terms of actual foodstuffs produced and consumed. We shall here, in fact, be confining ourselves almost entirely to the foodstuffs we all recognize. But before we proceed to an inquiry into human diets, there is one final proposition to set forth. It is simply this. Those, who do not agree that the average Chinese, Bantu or Malay has about the same size stomach as the average Londoner or New Yorker might well spare themselves the tedium of the argument that follows. The biologist has no such escape, whether he likes it or not. He can make no distinction between man and man, save in so far as he may be led to modify his dietary estimates to accord with differences of climate, physical type, and normal mode of life.

Comparisons in Milk Consumption

There has recently issued from the American Department of Agriculture an estimate, doubtless still of an unofficial nature, of the extent to which post-war agriculture will have to expand world production in order to meet human requirements. The estimate is based on the pre-war figures and apparently contains no reference to war-time disturbances. The writer begins with the statement that the diet of two-thirds of the world's population has been inadequate for healthful living, even in normal times. He then suggests that, to meet the needs, cereal production will have to be expanded by 50%, that of meat, fish and poultry by nearly 100%, that of vegetable oils by 125%, that of milk and milk products by 150%, and, finally, that of fruit and vegetables by over 300%. We may well pause for a while upon these percentages. We have at present no information of the process by which they are reached, though it is understood that the dietary standards applied were by no means high. But in two extreme directions the figures are severally surprising.

Take, for example, the proposed expansion of milk production by 150%. A decade ago the average inhabitant of Britain consumed each year a fair quantity of milk, cheese, and butter. Calculated in terms of its liquid milk equivalent it amounted to about 700 pints; the average American consumption was about 640 pints. This is a respectable level of consumption, though it is not so high as that of New Zealand (over 1000 pints per annum) or that of Switzerland (890 pints per annum). Yet we find various estimates of the extent to which it is desirable to raise the level of consumption in Britain and America. These estimates range about the level of 70% to 80%. But if so large an expansion of the dairy industry is required in these two favoured countries, what shall we say of Poland, where the annual consumption of milk in all forms amounted a decade ago to about 394 pints, well below half the level reached by the Swiss? The average Italian consumption at the same period was recorded as approximately 183 pints per annum, not much more than a quarter of the British level. Two countries widely separated from one another may be instanced as cases of low milk consumption. Bulgaria a decade ago had an average consumption, of fresh milk only, of 52 pints per annum. Chile's fresh milk consumption was one of 47 to 52 pints, less than 20% the average Danish consumption. Of Chile it has indeed been officially stated that if all milk were kept for children one to nine years old on the basis recommended by the physiologists, there would still be insufficient milk in the country; this is the assumption that no butter or cheese is made and that all children below one year are breast-fed.

The relatively high milk consumption in a few of the countries of northern Europe and of North America and Australasia contrasts strikingly with the low returns from southern Europe and the Balkans, so far as these are available or may be surmised. The contrast with eastern and southern Asia is scarcely worth analysing. In Japan very little milk is drunk by the people; one estimate gives the average consumption per head as less than 15% that of the negligible Chilean intake. Most of the Chinese populations have little or no milk. One survey suggests that Peiping coolies get about 0·9% of their daily energy from milk and Shanghai coolies about 0·3% from milk and eggs together. This would give the average Peiping coolie considerably less than ½ pint of milk a week. Surveys in Southern India agree fairly well that about one half the families examined drank no milk; only 28% of the families drank more than a third of a pint or so a week per head. The poor rice-eater's diet seems, in fact, to be very similar in composition throughout India; milk is taken in negligible amounts or not at all.

Since we are here, on the Asiatic continent, dealing with more than half the population of the world and since the dairy-farming communities are relatively small and scattered, it seems unlikely that a 150% expansion in milk production would here make any significant change in the diet. But the U.S. Department of Agriculture is doubtless conservative in its estimates; and we may close the matter where the League's Final Report closes its brief survey of the Far East, with the remark that "in Asiatic countries any immediate increase in milk, eggs and butter is out of the question". It does not follow, however, that we should make no effort to resolve the dilemma.

Cereals Consumption

But the statement that we should look for a 50% expansion in the world's production of cereals raises quite a different problem. This is a very serious proposal, even if part of the increase is for fodder purposes. Most of the world depends upon cereals for the greater part of its available supplies of human energy; and what can such a statement imply but that the energy derived from such crops as rice, wheat, maize and rye is to be raised by something approaching 50%.

What is the present position? According to one estimate about a tenth of the world's population, concentrated mainly in the United States, Britain and her Dominions, relies for no more than 30% to 40% of its human energy upon cereals and potatoes; the remaining stores of energy are supplied from a varied diet of fats and animal and vegetable foods. A further 25% or so of mankind, concentrated mainly in Central and South America and in the western and central areas of Europe, has to rely on cereals and potatoes for 40% to 70% of its available energy. Almost two-thirds of the world's population, on the other hand, derives 80% or more of its energy from cereals; and this remnant spreads over the eastern area of Europe, over Asia and over a considerable portion of

Africa. The estimates may be accepted provisionally, though they do not allow for the slowly changing standards of diet in the U.S.S.R. or distinguish the varying standards peculiar to the class levels in any one country. On this assumption, then, the diets of most of the peoples of eastern and southern Asia must have been seriously deficient in total energy, even if we suppose that part of the proposed increase in cereal production is for the feeding of live stock.

It is perhaps worth our while to record a little more exactly the extent to which the different nations of the world subsist upon a diet of cereals and potatoes. A diet of which 80% is composed of rice or bread is clearly a very monotonous diet. It has been suggested that the average Burmese or Bulgarian may prefer a fairly high proportion of such foods in his diet; and possibly he does, though there is reason to doubt it. In any case the proportions of such foods in the national dietaries do correspond broadly with estimates of incomes per head of population, analysed nation by nation; briefly, whatever part the palate may play, the ultimate influence is simply that of purchasing power. Few people would care to get more than 60% of their daily energy from bread alone, even if few people, however varied their choice of food, would care to lower their bread consumption below 20% or so, once they had made bread a normal feature of their diet.

It does not necessarily follow that those, who are reduced to a diet consisting mainly of cereals, will be malnourished. That depends on the composition of the remaining 20% or 30% of the diet. A population that has sufficient sugar and fats in its diet, as many have not, can afford to depend upon cereals for about half its daily energy; otherwise it is compelled to resort to a cereal and potato diet in the main, whether it likes it or not. But apart from that, all the evidence goes to show that the peoples whose diet contains more than 60% of cereals or potatoes in terms of energy are nutritionally poorly provided; their consumption of dairy produce, meat, fruits and vegetables is usually inadequate and often negligible. The relative prices of the different foodstuffs, both for the producer and for the urban consumer, are the important factor. In the last decade, for example, a citizen of the United States would frequently have had to pay eleven times as much for an inferior cut of beef as he would to obtain an equivalent amount of energy value from a portion of wheat flour to bake into bread; if he desired to get the same amount of energy from milk, he would have to pay eight times as much; and if from eggs, fifteen times as much.

Thus the proportion of cereals and potatoes in a national dietary may be taken as a measure of the prosperity and of the nutritional level of the majority of the population. In the table below, the facts, so far as we know them, are summarized. The nations of the world are divided into six groups, according to the part played by cereals and potatoes in supplying their daily energy. Necessarily not all the inhabitants of the globe are here included; and in many cases the estimates have been made from statistics of production and trade. But the figures give the broad order of comparison between nation and nation. Typical examples are recorded for each group, together with the total population falling within each group and the percentage relation of that population to the total population of the world in the last decade.

TABLE OF COUNTRIES, SHOWING THE PART PLAYED BY CEREALS AND POTATOES IN THEIR SUPPLIES OF HUMAN ENERGY.

Group	*Percentage of Cereal-Potato Calories in Total Calories*	*Typical Countries in Group*	*Population*	
			Number in Millions	*Percentage of Total*
1	30-39	N. Zealand, Australia, Sweden, U.S.A., Canada, U.K., Switzerland.	205	11·1
2	40-49	Austria, Denmark, Norway, Finland, Germany, Netherlands.	93	5·1
3	50-59	Argentina, Hungary, Czecho-slovakia, Belgium, France, Uruguay.	93	5·1
4	60-69	Mexico, Chile, Italy, Spain, Greece, Brazil, Peru.	169	9·2
5	70-79	Bulgaria, Poland, Japan, Tunis, Yugo-slavia.	156	8·4
6	80-89	India, Java, Rumania, China, Indo-China.	1,125	61·1
		Total	1,841	100·0

It will naturally be appreciated that, both in the above estimates and in all subsequent figures, we are dealing only with the pre-war position. Many changes may have been produced by the war; but their extent is incalculable; and we can at least be sure that they have not altered the relative situation between one country and another.

The Monotony of Rice

Rice is said to be the staple diet of half the human race. This may be excessive; the area of wheat and other grains may have tended to expand somewhat in recent years. But it is safe to allow that rice is the main staple of 700,000,000 people spread over Bengal, Madras, Ceylon, Malaya, the Asiatic islands and the southern regions of China. Some confirmation for the statement that many of these folk derive 80% or so of their energy from rice is provided by a few surveys in India and China, though the proportion of rice in the diet varies; and, as we have seen, Japan as a whole appears to be slightly superior to the other populations of the Far East. The broad picture conveyed by investigators in Southern India, in Thailand and in Indo-China is of a diet of extreme monotony. In such rice-exporting countries as Burma and Thailand far too little attention has been devoted to the encouragement of a mixed peasant cultivation; and in poor Indian households the consumption of meat, fish and eggs was found to vary from negligible amounts to 0·7 oz. per day per head, while that of vegetable oils ranged from 0·2 to 0·5 oz.

Crop production figures, particularly for the Asiatic countries, are naturally very unreliable at present; but we may be permitted to make use of such estimates as are available. In the year 1936 the continent of Asia (excluding the area of the U.S.S.R.) was recorded as having

produced 87,150,000 tons[1] of rice. Of this crop 2,100,000 were exported from the continent, mainly for European markets; and the balance of just over 85,000,000 tons presumably went into domestic consumption. If, as we conservatively estimated, this stock of rice has to support most of the vital energy of some 700,000,000 human beings, then it becomes clear that it provides somewhere about 0·75 lb. of rice per head per day for the whole population. This in terms of energy is equivalent to about 1,400 Calories. That is not a high expenditure of energy; it represents roughly 80% of the daily requirements of a placid Indian child for some nine years. There is evidence that the gross intake of the average South Indian peasant, attempting to do a day's work, is almost as low as this rice figure of 1,400 Calories for a mixed population of all ages would suggest. Aykroyd, for example, puts the intake of the adult poor peasant as roughly 2,600 Calories. A man in South India doing a moderate day's work of eight hours ought to expend at least 2,800 to 3,000 Calories; and the extent to which he falls short of this is a fair measure of his deficiency.

In the face of evidence from the Medical Services in India itself, one is inclined to suppose that these figures present too favourable a picture. In 1933 the Director-General of the Service estimated that in all India some 40% of the villages showed a population that was excessive in relation to the food supply; the percentage was 46·0 in Bengal and the Punjab, and rose as high as 60·0 in Bihar and Orissa. Perhaps after all there is some truth in the statement that India has for many years been the country where "there are always three mouths for every two rice bowls".

Some Pointed Variations

This seems to require comment. Doubtless such countries as India or China will have to contemplate various provisional plans for expanding their food production; in China, for example, an immediate effort to extend the cultivation of the soya bean would probably be beneficial. But we must also have more remote plans in prospect; the Chinese might not be content to rely in perpetuity upon soya flour for a significant proportion of their daily requirements of protein and fat. Now, we can lay down the standards, to which the Chinese or the Indian diet ought to approximate, in terms of protein, vitamins, mineral salts and the rest of it; but on what principle shall we convert these abstract standards into the terms of the foodstuffs that are actually to be produced and consumed?

There is no principle except that of the likely preferences of the people themselves. The energy value of a given quantity of bread may be equal to the energy of a given quantity of sugar; but obviously most civilized nations prefer to secure some of their daily supplies of energy from sugar. In other words, what is in some respects a subjective or psychological standard of selection turns out to be the only *objective* standard to which we can appeal, assuming of course that the public concerned has a due sense of the dietetic fitness of things. In planning for a "freedom from want" economy we shall have to consider to the best of our ability what foods the world prefers to consume; and our only guidance in this is to discover what foodstuffs the people of various countries normally tend to consume when they have the chance.

In all cases where we have records of the diet of families at different class levels, a rise in income is almost invariably accompanied by an urge to seek out and consume more of the foodstuffs of higher quality such as milk or fruit or meat.

New England families, with an income of 500 dollars were consuming in 1935 about 2½ times as much fruit per head as those on an income of 300 dollars and under; they were consuming 1½ times as much meat and fish. In South Africa the urban families of European stocks who earned an income of £600 or thereabouts were consuming in 1936 about twice as much butter per head as were those on an income of £175 or under; they were consuming four times as much fresh milk. In comparison with a Western European diet, that of a Peiping teacher has been poor in meat; yet he secured six times as much as did a Peiping coolie; he further varied his diet with considerably larger quantities of sugar, vegetable oils and fruit, though his purchases were still relatively low. Yet in each of these instances and in the many others that could be adduced there is not the remotest doubt that we are, in the main, dealing with families of the same racial type and the same type of palate.

Most of the peoples of the globe appear, then, readily to acquire a taste for the more varied, and incidentally, the more nutritious foods; and we must assume that these trends in preference will have to be considered, when we are deciding on our policy for world production.

Uneven Distribution

If we allow that the productivity of the world has fallen far short of its dietetic requirements, we must further be struck by the indubitable fact that such food as there is has been very unevenly distributed among the world's populations. Since it will take some few years to raise production anywhere near the desirable level, we in this peculiarly favoured country would do well to ponder the meaning of the inequitable distribution. Which policy shall be first pursued? Shall we attempt first to even out the currents of distribution flowing about the world? Or shall we attempt to keep matters as they are and merely content ourselves with assisting the agriculturally backward peoples to expand their cereal cultivation and develop their dairying industry and their fruit and vegetable production? It is possibly worth our while to give a few examples of the present trends in world trade.

Most peoples prefer, where they can, to replace a portion of their cereal foods by an increased consumption of sugar. Within limits this is a natural and a wholesome tendency in food habits. British sugar consumption per head is estimated to have increased five times in the last century; and American consumption from three to four times between 1850 and 1930. Yet in most of the Asiatic countries the consumption of sugar is still negligible; and the contrast between sugar consumption levels in America and those in several of the countries of South and East Europe remains very significant. The average Serb, for example, was consuming a decade ago less than an eighth

[1]Tons are stated throughout as metric tons (2,200 lb. to the ton).

the sugar eaten by his American contemporary, the average Spaniard little more than a quarter.

An examination of the flow of sugar on to the world market shows at once how unequally it has been distributing itself among the world's populations. In the year 1936 the great sugar-exporting areas around the Caribbean and in the East Indies disposed of some 6,000,000 tons of sugar on to the world market. In that same year Britain and North America between them imported some 5,000,000 tons. On balance, that is to say, these two consuming areas with less than 10% of the world's population absorbed some 83% of the sugar released on to the market from the main producing areas.

This canalization of the world's trade in food stuffs is even more remarkable in the case of fruit. The figures for the year 1933 appear to be fairly reliable; and the year has the further advantage that it fell between the depth of the financial depression and the extreme periods of national self-sufficiency. In that year the main countries of orange cultivation exported some 1,560,000 tons of the fruit; and of this more than 1,300,000 tons, or approximately 86%, passed into consumption in Britain and the countries of Western Europe, including Germany. A study of the figures suggests, in fact, that of the total orange crop of that year 95% was consumed in these few countries or in the countries of origin, which include, it will be remembered, the United States.

Of the available lemon exports in this same year over 80% was distributed unevenly through a belt of countries from Britain to Poland and Czecho-Slovakia. Of the exported bananas 71% divided themselves into two streams, flowing to the United States on the one side and to Britain and France on the other; most of the balance was taken up by Western Europe, Japan and Argentina. Britain again received almost 75% of the available canned fruit from the main exporting areas in North America, South Africa and Malaya.

Exportable raisins are produced mainly in the United States, along the Mediterranean seaboard, and in the Southern Dominions. Most of the fruit that leaves the country of origin is absorbed by Western Europe and Canada. In effect, little more than 11% of the total crop was consumed in 1933 outside these favoured countries and the countries of origin. There can be little doubt from the trend of these figures that the world's larder lies open to a relatively small proportion of the world's inhabitants. Yet in spite of the high consumption levels in the United States, we find it definitely suggested that to reach sufficiency that country should raise her intake of citrus fruits and tomatoes by not less than 30% to 40%; the measure of deficiency in most of the world may be tacitly inferred.

Unequal Tides of Edible Oil

Most peoples tend, where they can, to increase their daily consumption of such fats as butter, margarine, and oils; indeed, those in a position to do so might normally derive 20% to 30% of their supplies of human energy from these sources alone. The reason is obvious. Not only do the fat foods give variety to the diet, but weight for weight they yield far larger supplies of energy than do rice, bread or lean meat. Were the figures available, it would be even easier to compare the relative prosperity of different countries in terms of their consumption of fats per head than in terms of their consumption of cereals and potatoes.

So varied are the sources of fats and oils, that it would require a lengthy exposition to trace their distribution among the nations of the world. But we know, of course, that since the last decades of the nineteenth century the countries of Europe and of North America, finding their production of butter and animal fats insufficient for their needs, have reached out to acquire increasing reservoirs of edible oils. These reservoirs were primarily those of vegetable oils derived from oil-bearing plants, mainly cultivated in the eastern and southern areas of Asia, in North and East Africa and in areas on the Atlantic seaboard of South America; subsequently they were further derived from the whale fisheries of the Antarctic. It is true that by no means all these products are used for the manufacture of human foods; some of them indirectly support human life through their use in animal feeding and some are employed for industrial purposes. But in recent years the proportion diverted for such industrial purposes as the manufacture of soap has tended to fall. By 1929 the output of margarine in Europe had reached 1·1 million tons and was rivalling the butter output of 1·4 million tons.

These tides of edible oil, released by the fat-hunger of a few relatively prosperous countries, have naturally flowed in uneven currents about the earth's surface. The average annual export of vegetable oils in the years 1934-6 from their countries of origin was 3,240,000 tons; of this about 760,000 tons came from the African areas of cultivation and about 1,910,000 tons from Asia. Of this more than 3,000,000 tons or over 90% was distributed among the countries of Western Europe (including Germany), North America and Japan. Meanwhile, the average annual production of whale oil in the Antarctic during the years 1935-7 was 515,000 tons; and of this some 80% was ultimately shipped to the United States, Britain, Germany and a group of the smaller Western European and Scandinavian countries.

It would be difficult to compute precisely what this implies for the peoples of the African and Asiatic continents. Between them (excluding the U.S.S.R.) they probably produce more than half of the world's annual supplies of vegetable oils of all kinds, if these be reduced to a common basis of calculation. But of this they appear normally to export almost a half; and their imports in terms of butter or processed oils are insignificant, while their internal trade in their own products is not of a high order. Thus this fraction of the human race, about 60% of the world's population, has at best little more than 25% of the world's edible vegetable oils on which to indulge itself.

The Problem is Set

As we have remarked, all this raises some serious problems, particularly for the heavily importing countries. With the exception of the United States, all meat, butter, and fruit exporting countries have small populations. Several of them have a fairly high level of consumption of the foodstuffs in which they deal. But the main importing countries also cover between them a very small percentage

of the world's population. Omitting the United States, which only enters the market significantly for sugar, vegetable oils and some fruits, we find that a large proportion of the overseas trade in foodstuffs is diverted to about 7% of the world's consuming public. Thus, some 10% to 15% of the world's population appear to be engaged in distributing among themselves the large bulk of the annual reserves of meat, sugar, fruit, and dairy products. The point is that there exists, in the nature of things, no reason why a very fair proportion of this relatively small surplus of food should not pass to other consuming publics, say, in the Balkans, in South America and in China. We have been exerting a magnetic influence upon the food markets, not because there has been a superabundance of the various foodstuffs but because there has been no effective competition.

Yet it only requires to raise the effective demand in China by 10% to make China a competitive importer of Javanese sugar, Australian beef, and New Zealand butter.

The immediate effects of a move towards a "Freedom from Want" Economy would not be felt in the pattern of the world's markets alone. It is necessary to grasp the fact that a number of the food exporting countries reject their foodstuffs, not because their population is already overfed but because they need to purchase raw materials, textiles or machinery. In some instances, as with Burma, Cuba and Jamaica, they had neglected stock-raising and vegetable culture for their own subsistence, in favour of the monoculture of rice or sugar or bananas. Under a more wholesome economy they would divert some of their labour to the adequate feeding of their own people. At the other extreme there are perhaps five or six exporting countries who could in the immediate pre-war years boast that they still retained within their borders a sufficiency of food for the whole population; these true surplus exporting countries are Denmark, Canada, Australia, New Zealand and possibly Argentina or Uruguay. Even in these countries the diet of the poorer classes often left much to be desired. As for the body of small food-exporting countries represented by Algiers, Turkey and South Africa, it is doubtful how far they would remain on the world market, if they so adapted their economy as to provide first for the needs of their own inhabitants.

The case of South Africa may be studied a little more closely. South Africa has a population of about 10,000,000 of whom some 2,000,000 are of European stock. A recently published article, the writer of which unfortunately does not reveal the full sequence of his calculations, gives some interesting figures of food exports from that country; these figures are, as far as we can see, correct. In brief, he estimates that South Africa produces sufficient fruit to supply her whole 10,000,000 inhabitants on a fair basis of adequacy, but that her normal yearly export of fruit reduces the domestic supplies so far that sufficient remains for no more than 5,000,000. He adds that the country might have had butter enough for 3·5 millions; but that normal exports reduce the possible consumers to a level of 2·6 millions. An already insufficient supply of meat, fish, and eggs is still further restricted by the export policy.

We are not here concerned with the measures that would have to be taken to raise the level of productivity and transform the farming economy of this and many other countries. The process is one that will take time; and it is first proper for us to convince ourselves that it is necessary. The world has not been merely relatively but absolutely short of food; as far as available supplies of meat, fruit and dairy products are concerned, it has been literally starved. When humanity sets itself the primary task of re-establishing the true relationship between man and his food, the early stages of the process are bound to involve some disturbance of the traditional markets. The heavily importing countries will have, for the time being, to rely more upon their own productive resources. But the process will make an increased demand upon the science of agriculture; and we shall need to train and equip a multitude of young research workers to deal with the complex problems of food production in many diverse regions. It is a great life's work, no less than that of raising the human species at long last to its full stature and significance as the Master of the habitable earth.

There is one final comment that must be made. The estimates we have given are based upon production and consumption figures, which we have agreed to be in some measure conjectural. Export and import figures may be more satisfactory than those for production; but they still leave much to be desired. Diet surveys carried out in such countries as China and India cover small samples of the population, though their internal consistency frequently gives one some confidence in their results. Taking it by and large, the estimates reveal the broad trend of food consumption throughout the world; they show that something is seriously amiss; and they supply us with a mass of converging evidence, that prompts us to immediate action. Beyond this we can make no claim for the evidence adduced, unless that it places in our hands the scientific instrument we need for a more systematic analysis of the world's food requirements.

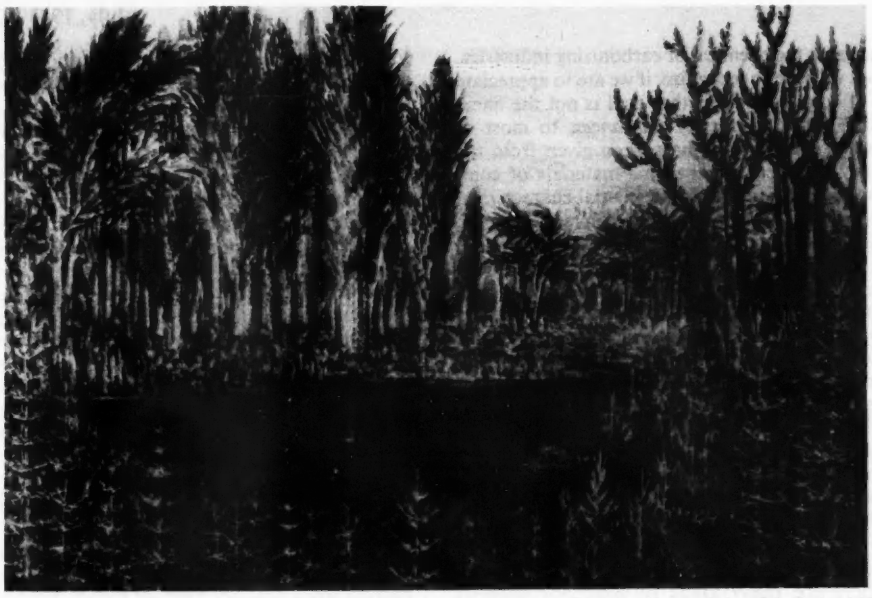


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FIG. 1.—Reconstruction of part of a 'Coal-Forest." Coal is a product of the decomposition of various kinds of plants. Most of the material accumulated in a more or less waterlogged condition where it fell, while some of it was washed into lagoons and streams that broke the continuity of the forests.

Coal Research; its foundations and principles

F. J. NORTH, D.Sc., F.G.S.

COAL has been known in Britain since the Bronze Age and was occasionally used by the Romans. In the thirteenth century it was regarded as a good fuel for smiths and lime-burners, and by the sixteenth century had become widely adopted for domestic purposes. During the last hundred years the output from British mines has risen from about 20,000,000 tons to over 200,000,000 tons, and coal and its products have come to play an essential part in every phase of life—for it is not only a fuel, a source of light, heat, and power, but also the raw material for innumerable industrial processes.

This being the case, the proposal to spend £1,000,000 on research directed towards the better utilization of coal, recently announced by Sir Evan Williams at a meeting of the British Coal Utilization Research Association, might seem to be unnecessary and extravagant. Surely, it might be thought, in all these years the users of coal have found out all that it is necessary for them to know about it! What more can they hope to discover, and how do they propose to set about it?

It would require the "inner knowledge" of an official of the B.C.U.R.A. or of the Fuel Research Board adequately to answer the second part of that question, and even an individual so privileged would probably find it inexpedient to do so in detail, with industrial and international affairs in their present confused condition.

The first part can, however, be discussed in general terms, and it is desirable that the man-in-the-street should know more about the fuel he has for so long taken for granted, and has used so inefficiently that, taking all its fuel applications into consideration, quite 70% of its potential energy is wasted. Thirty years ago the wastage was of the order of 85%, so that, in a comparatively short period in relation to the length of time during which coal has been freely used, research has doubled the efficiency of the coal-consuming plants and processes. A result like this justifies the belief that further research in the light of the knowledge that has already been obtained will lead to still greater efficiency, and will enable us to use this national asset to even better advantage.

If we wish to understand the trend of modern coal-research, we must first know more about coal itself than its price, and the quantity of "slack" and "slate" which a consignment includes. It is because people, generally, have been satisfied with information relating to these three characteristics, as though they were all that mattered, that it was found necessary to launch a Fuel Economy Campaign.

A typical dictionary definition of coal is: "A black, solid, opaque, carbonaceous substance of vegetable origin, obtained from strata usually below the surface, and used for fuel," but that definition mentions only the properties that are common to the coals from all the mines in Britain, and contains no reference to the properties that are variable, and it is these properties that influence the behaviour of coal when it is used as a fuel, and determine its suitability

as a raw material in the chemical or carbonizing industries.

The first fact we have to recognize, if we are to appreciate the purpose of coal-research, is that coal is not the name of a substance, but of a *class of substances*, to most of which distinctive names would have been given from the time when they first began to become materials of commerce, had not the obvious but non-essential characters of blackness and opacity been common to them all.

As it is, numerous descriptive terms have come into use, and in some cases have been adopted for trade purposes, e.g., bituminous coal, house coal, gas coal, steam coal, semi-bituminous coal, anthracite, stone coal, cannel coal, and so on; these relate to significant properties or to the use to which the variety so named is generally put, but there are also other names, such as duff, peas, beans, nuts, cobbles, large, and run-of-mine or through coal, which relate to the size and grading of the fragments that are marketed: these give no direct information about the chemical properties of the coal, but they are important, in that the size of the fragments has to be considered in relation to the appliances in which the coal will be burnt, or otherwise used.

This popular commercial nomenclature not only indicates that there are many kinds of coal, but suggests that each of the various kinds has properties by reason of which it is regarded as being more suited to one purpose than another, and one of the principal objects of modern coal-research is to increase the accuracy and extent of our knowledge of the properties and potential uses of the varieties that are available.

Work in collaboration with the users of coal and the makers of coal-consuming appliances must be undertaken with a view to ensuring that the maximum possible return is obtained from all the coal that is used, while the industries in which coal is a raw material must be increased in number, variety, and efficiency: then, in order that all this knowledge may be used to advantage, it will be necessary to devise a simple scheme of classification that will make it possible for a vendor to indicate the kind of coal he has for sale in terms such that a prospective buyer will know within reasonable limits whether it will meet his needs. Such schemes have already been proposed and freely used, but those which are scientifically sound have characteristics which militate against their use for general and trade purposes and require simplification, if it can be accomplished without loss of essential accuracy.

We can best explain and appreciate the origin and significance of the variable properties of coal in the light of what we know concerning the materials from which it was made, the conditions under which they accumulated, and the modifying influences to which they have been subjected.

Coal Formation

Coal began in forests that thrived in long-past ages, but the products of the forest growth only became coal when certain physiological conditions prevailed; and while those conditions have occurred several times and in many areas during the geological history of the earth, they were most widely spread and lasted for the longest time at one period, known in consequence as the Carboniferous Period. In terms of modern views concerning the age of the earth, coal-forming conditions in this period were established about 240,000,000 years ago, and continued for about 30,000,000 years.

Recognizable plant fragments in the coal itself, together with fossil plants in the rocks (the Coal Measures) with which coal seams are interstratified, and the characters and structures of those rocks, enable us to reconstruct in imagination the successive stages in the formation of a coal seam and to envisage forests extending over wide areas sufficiently near to sea level for the dead and decaying vegetation to remain more or less water-logged; in these circumstances, instead of the products of decomposition being mainly gases discharged into the atmosphere, as is the case when plant-debris decomposes in the open air, they were in large measure either solids or liquids that mixed with or dissolved in the available water, and so tended to accumulate—the solid debris soaking up the liquids as a sponge soaks up water.

In such circumstances there would be widespread accumulations of damp and decomposing vegetable debris in many ways resembling certain kinds of peat. This material would be liable to vary in constitution from layer to layer and from place to place, because it would have been derived from different *kinds* of plants, from different *parts* of plants (leaves, twigs, stems, spores), from materials that, like the contents of plant-cells, were easily decomposable, or that, like the coats of spores and the cuticles of leaves, resisted decomposition to such an extent that they can be recognized in, and in some cases actually extracted from the coal, after their extraordinarily long period of mummification.

There were, within the forests, lagoons into which the finer plant detritus was washed, to mingle with or to be intercalated with mud or sand brought thither by streams that quietly drained the swampy tracts.

Various plants and various parts of plants; varying degrees and conditions of decomposition; varying amounts and dispositions of incombustible matter to supplement the mineral substances that were present in the original plants—is it any cause for wonder that the coal of one mine differs from that of another, that the coal of one seam differs from that of another worked in the same mine, or that, in one seam, the coal from one layer may differ from that of another layer only an inch or two away?

The accumulation of the material of a coal seam was brought to a close when subsidence, either local or widespread, allowed the forest debris to be overspread with sand or mud, which hermetically sealed the material beneath and initiated new conditions under which the conversion of plant-debris into coal could continue.

The sequence of events we have just described was repeated again and again in the regions which later were to become coalfields, and many hundreds or even thousands of feet of strata accumulated: most of the sediment was mud or sand, but the layers of forest debris were thick enough to give rise to coal seams from a few inches to many feet in thickness, and numerous enough to give rise to several workable seams in any one area—in part of the South Wales coalfield, for example, there are more than 20 seams, and many individual mines derive their coal from two, three, or more seams situated at successively greater depths.

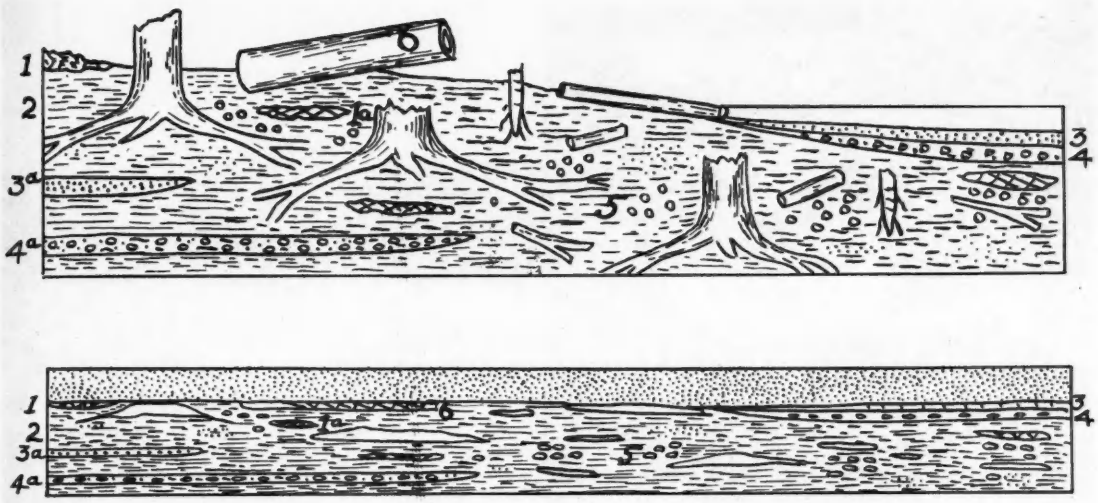


FIG. 2.—Diagram to show why Coal varies in character from layer to layer and from place to place.
The upper section depicts the material as it accumulated in the coal forests, and the lower one the same material after it had been buried beneath sand and mud, and compressed. The relative size of the various plant entities is greatly increased in the upper diagram, and the actual amount of compression was much greater than is suggested by the lower one.

During the long period that has elapsed since the close of the Carboniferous era, the Coal Measures shared in the effects of compression and folding, of upheaval and depression, and of erosion and denudation—processes that have been responsible for the building up of the rocks of the earth's crust and the shaping of the earth's surface features. In consequence, the coal seams have been buried more or less deeply beneath the surface, and have come, to a greater or a lesser extent, under the influence of the high temperatures which there prevail; they have also been affected by the pressure due to the weight of the strata deposited upon them, and to stresses, both of compression and tension, that accompanied the movements within the earth's crust that have thrown rocks into folds and have built up mountain ranges.

Subjection to the conditions which resulted from the operation of these geological processes gave rise to chemical and physical changes within the coal-substance: some of the constituents were decomposed and the others underwent reconstruction, the results varying according to the nature of the original material, and according to the degree of heat and pressure to which the products of its decomposition were exposed. In this way a new set of variable characters was superimposed upon those associated with the original materials and their conditions of accumulation, so that well-directed coal research will involve attention to the geological history of the coalfields, as well as to the behaviour of the coal in the laboratory and the experimental utilization plant.

Properties of Coal

We are now in a position to consider the nature and the extent of the variations that are met with in the class of substances called coal, and at the same time to understand something of the causes to which they are due.

The most striking of the variable properties of coals are those related to the amount of volatile matter (gaseous and liquid products) that they yield when heated, or that is liberated during the progress of combustion. This may vary from more than 40% in some of the coals from the north of England to as little as 5% in some of the anthracites of South Wales.

Accompanying these variations in the amount of volatile matter that can be obtained there are also variations in the manner and condition in which the gases and liquids are liberated; some coals begin to decompose at lower temperatures than others, and for the same coal, the amount of the volatile products increases with the temperature to which the coal is raised, and their nature also varies. For example, not only is the yield of tar greater at low than at high temperatures, but the tar contains different constituents; more phenol is produced at low temperatures, but little anthracene or naphthalene, and as these substances are important raw materials for the chemical industries (including dyes, drugs, explosives, and plastics), it is a matter of national importance to know exactly how the various kinds of coal behave in certain circumstances, in order that a proper balance may be maintained in the supplies of such materials. The oil yield from coal also varies with the temperature at which it is treated, as well as with the coal itself. The liquid products of carbonization at low temperatures contain more oil than those resulting from the exposure of the same coal to high temperatures.

The significance of these variations in properties and behaviour can also be indicated by reference to certain extreme cases: anthracite, with only about 5% of volatile

(*Continued on p.* 198.

Large-scale Planning in the U.S.A.

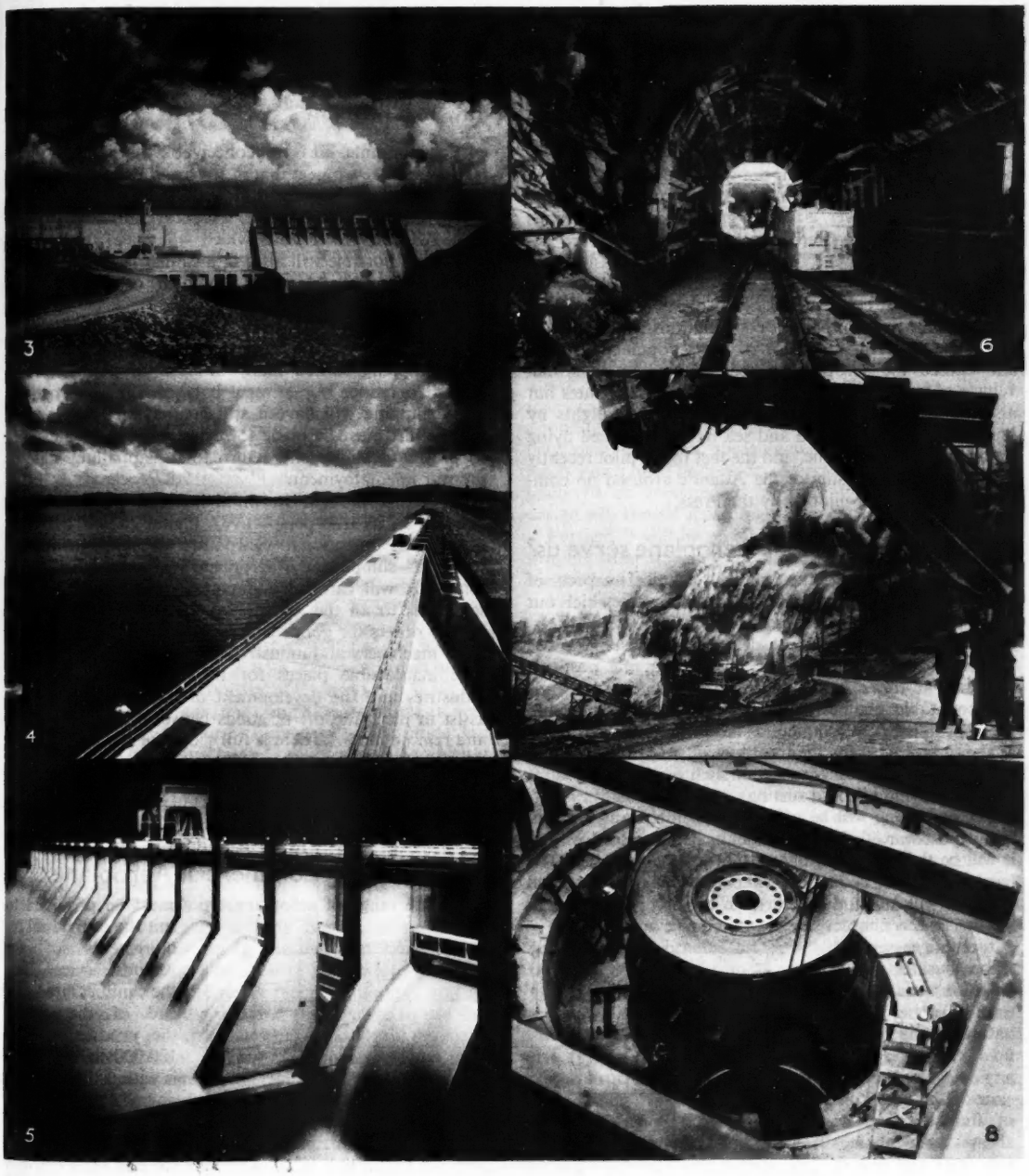
For the past nine years, one of America's great regions, the Tennesee Valley, has been in process of a multi-purpose development by a Federal corporation, the Tennessee Valley Authority, working in partnership with institutions already on the ground. The development is directed toward the optimum productiveness of the farm lands, rivers, forests, and minerals; and toward optimum use of the region's productiveness for the good of all the people of the U.S.

Among the elements of the development are restoration and strengthening of soil and forest; harnessing of the rivers for navigation, flood control, and power production; distribution of the electric power to the largest possible number of people at the lowest practicable cost; operation of the Government's chemical plants to produce farm fertilizers in peace-time and munitions in war-time; gathering of information about the location, quality, and extent of soil, forest and mineral resources; and research to make the region's resources immediately available and to enhance their usefulness.

The Tennessee Valley Authority's power generating system, one of the largest in America, is supplying huge quantities of vitally needed power to war industry, and its capacity is rapidly being increased. Munitions and an ingredient of synthetic rubber are being produced at chemical plants. Plans are in progress for the construction of public terminals to utilize the navigation channel in the Tennessee River for the growing war-time transportation of freight. Houses are being designed, built, and operated for workers in war industry. Mapping is being done in strategic areas for the U.S. War Department. Among the first-ranking contributions by the Tennessee Valley to the conduct of the war are the activities concerned with the production and utilization of food and forest products.

THESE P.CTURES SHOW SOME OF THE DIFFERENT ASPECTS OF T.V.A. CONSTRUCTION

1. *Draft tubes, forming the generating units in the Fort Loudon powerhouse. Concrete is shaped by being poured around the wooden forms.* **2.** *Workmen "spotting" points for core drilling at site of Douglas Dam.* **3** *and* **4.** *Cherokee Dam on the Holston river. Cherokee Lake behind the dam stretches for* 58½ *miles up the Holston River, covers* 31,100 *acres, impounds* 1,473,000 *acre-feet of useful storage.* **5.** *Chickamouga Dam,*



here shown under flood-lighting, is on the river in the eastern part of Tennessee. **6.** *A view of the 8-mile-long tunnel driven through rock in the mountains of N. Carolina to carry the entire flow of the Hiwassee River.* **7.** *In the biggest blast ever performed in the South of the United States an entire hillside at Cherokee project tumbles under a charge of 62 tons of dynamite.* **8.** *One of the turbines at the Cherokee Dam being lowered into position.*

Developments in Post War Civil Aeronautics

D. HAY SURGEONER, A.F.R.Ae.S.

CIVIL aeronautics in the immediate post-war years will not be greatly different from pre-war aeronautics, because no major technical developments have occurred during the war. War is, however, a forcing ground, and those things which in peace time were merely pointers to future development have now become realities and the designer of post-war aeroplanes will be far richer in material and scope than his pre-war colleague.

One of the most important contributions which the war has made to aeronautics is that it has popularised flying and caused the aeroplane to be accepted as a normal vehicle of transport, not only for short internal routes but also for global routes. Long-distance routine flights by military aircraft over land and sea have established flying in the minds of the public, and the fact that a pilot recently made his 100th crossing of the Atlantic aroused no comment, either by the pilot or by the Press.

How will the Post-war Aeroplane serve us?

Before considering the purely technical aspect of aeronautics, let us try to define the objective to which our post-war efforts are to be aimed.

In recent months a great deal has been spoken and written in Parliament and the Press about the post-war era, and at times it has seemed that aviation in some unaccountable manner will solve all our economic and social problems. Word pictures have shown the aeroplane as the only vehicle for the transport of people and freight, and inevitably the background of such pictures is of ships and trains lying idle and rusting.

The aeroplane will be a factor—an important factor—in our post-war life, but do not let us delude ourselves that it will be the only form of transport. It cannot be. The hard hand of the economist will control air transport, and whilst it will applaud the carriage by air of goods of an urgent or perishable nature, and passengers whose business or inclinations are of an equally perishable nature, it will be held up in horror against any suggested diversion of the vast bulk of freight from the cheap and satisfactory rail and sea to the air.

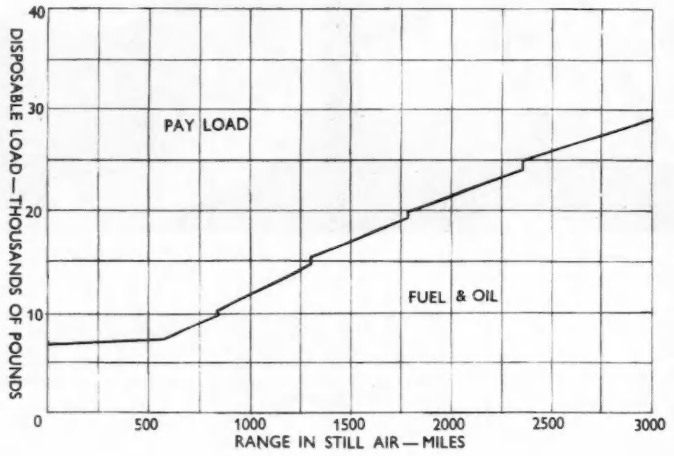
The selection of a particular vehicle to transport a given load must be justified on economic grounds, which for general purposes may be considered in terms of cost per ton-mile. It is not conceivable that the cost of air transport will ever meet that of sea transport, and although the former will decrease during the next 20 years as its application increases, the technical development in materials and power units which will make further cost reductions possible will also, in a similar manner but to a lesser extent, assist the development of shipping and railways.

The standard of living in this country depends to a great extent upon international trade, and in the pre-war years shipping earned many millions of pounds which helped to reduce our adverse balance. In the post-war years shipping will have a still greater part to play, for every effort must be made to secure a credit balance and so prevent a slump and return to the appalling state of pre-war unemployment.

With this thought in mind we can place post-war aviation in its true perspective. Planned from the technical and operational viewpoints to supplement—not supplant—shipping, the aeroplane will be a considerable force. It will carry manufacturers' samples and representatives to all the markets of the world to secure for Britain orders for goods which will follow by boat; it will carry machinery and industrial plant to remote and otherwise inaccessible places for the establishment of new industries and the development of old ones; and it will assist in the transport of goods between railhead or port and remote parts. There is full scope for the aeroplane in these and similar activities where high speed and accessibility are of immediate importance, and in addition it will carry a large percentage of long-distance passenger traffic.

The Post-war Commercial Aeroplane

A wide range of aeroplane types must be provided to suit the individual requirements of the various services. For the immediate top end of the range, the production of a 100,000 lb. aeroplane is within the scope of our ability and could be put in hand at once. Powered with six engines to give a total output of 9,000 horse power, it could cruise economically at 200 m.p.h. and carry 40% of its gross all-up weight, that is, 40,000 lb. as disposable load, divided between passengers



and freight as pay-load, and fuel and oil. The amount of pay load which could be carried on any flight would depend upon the range of the aeroplane between stops for fuel, and the graph shows the division of disposable load for various ranges up to 3,000 miles. The steps in the curve indicate the dead weight of fuel tankage.

Such an aeroplane would serve a very useful purpose, for it would be able to carry up to 100 passengers and some 5 tons of freight on a 3,000 mile flight, or more freight for a shorter distance. Increase of the all-up weight to 200,000 lb. is conceivable within a few years and to values above this as the aerodynamic aspect of the aeroplane is improved and materials and methods of construction are developed. This progress will enable the quoted figure of 40% disposable load to be increased, with consequent reduction of operating costs.

Control of Civil Aeronautical Development

Upon the answer to the question "Who will control civil aviation in the post-war years?" depends the success of this most important factor in our national life.

In the past the development of aeroplanes for civil purposes has been controlled by the Air Ministry, whose interests have been directed primarily towards military progress. That the interests of the Air Ministry should be so directed cannot reasonably be disputed, but to enable civil aeronautics to cope with post-war requirements we must place it on a firm foundation by separating it from Air Ministry control and, whilst allowing a free hand to private enterprise, linking it with other transport under the Board of Trade or Ministry of Transport.

It is true that in pre-war years civil aviation was a very small factor which had to be nursed by public funds, but its growth was hampered by the conditions under which it was allowed merely to exist; and instead of developing into a vigorous independent organization it was stunted and dependant upon the overflow from military requirements. Pre-war technical development was concentrated towards strategic advantage in time of war and no encouragement was given to those factors which were of interest primarily to civil aeronautics.

That private enterprise is fully capable of producing good aeroplanes is shown by the fact that some of our most successful military types were so produced, despite the Air Ministry. We have the technical ability; and all that we need now is the will and the courage to use this ability and the resources at our disposal to pursue a policy of development of civil aviation along lines indicated by the requirements of civil aviation. It must be done now, whilst our minds are keen and we have a reasonably clear view of our objective. Postponement until after the war will, inevitably, result in compromise and the loss of a good deal of what we rightly expect to gain.

Although there have been no outstanding technical developments during the war we have seen, again and again, that our long-established policy of producing general-purpose aeroplanes is most inefficient and if we apply this knowledge to the design of post-war aeroplanes we shall make a major step forward, technically.

The performance of any vehicle, particularly the aeroplane, depends upon the degree of approximation of operating conditions to design conditions and for maximum efficiency the two should coincide. The fulfilment of a specific purpose under specified conditions can most satisfactorily be achieved by one particular aeroplane and that aeroplane will perform most efficiently only when it is employed in work for which it was designed.

In pre-war aeroplane design a certain amount of compromise was justified, because the demand for air transport was small and the few available types were required to perform many varied jobs. Post-war design, however, must show no such compromise, because the demand for air-transport will be so great that specific purpose types will not only be justified but will be necessary.

A further point against the general-purpose aeroplane is that the design loads must be adequate to cover the worst case for each purpose. In the past, the determination of design loads has been largely arbitrary and recent experiments in measuring directly the actual loads imposed under various conditions of flight, have shown that in many cases these loads are less than the design loads. By adopting specific purpose aeroplanes it will be possible to determine by direct measurement in actual flight, the loads which must be considered under the flying conditions likely to be encountered by each type, and aeroplane design will benefit accordingly.

Further, it will be possible to effect a large measure of simplification not only the aircraft itself, but the equipment which will also be designed for the purpose.

The general construction of post-war aeroplanes will be little different from that of the immediate pre-war years. Stressed-skin metal construction, which uses a skeleton of spars or frames and stringers held together by an external skin or covering of metal, and which takes a good deal of the loads, will continue in the forefront. However, many of the claims made for the geodetic structure, which is an envelope built of light alloy members in the form of an extended trellis and covered with fabric, have been justified in the service given by the Wellington bomber, and we shall see more of this in civil types. Geodetic construction is particularly suitable for commercial aeroplanes because most of the wing and fuselage space is available for storage purposes, and the strength-to-weight ratio is high.

Many improvements have been made in constructional details and the benefits of these will be seen in simpler fastening devices and smoother external surfaces.

The success of the Mosquito has shown that the day of the wooden aeroplane is not over, and it is certain that this high-speed, clean aeroplane will have some effect on civil types. In commercial aircraft construction the bulk of the structural members should be as small as possible, and although timber in its usual form is very bulky compared with metal, a good deal of success has attended the union, under compression, of plastics and timber in producing a strong, light material with a bulk one-third that of normal timber.

Plastics alone are not yet suitable for structural parts, but laminated plastics using a fabric filler have been successfully used for a long time and are finding increasing application.

The stiffness of very thin metal sheets can be increased by bonding plastic to them and they are then able to contribute a good deal of their axial strength to the structure without buckling.

For the small, privately-owned aeroplane, pre-fabricated, plastic bonded components are not far off, whilst the development of plastics on a more comprehensive scale awaits the devotion of time and thought that only peace-time conditions will allow.

Power-unit Development

A comparison between pre-war and probable post-war aero-engines shows that the main differences will be increased boost and cylinder working pressures, and higher power output of single engines. Higher boost pressures have been made possible by developments in supercharger design and higher cylinder working pressures by a fuller application of 100 octane fuel. Developments in auxiliary equipment such as sparking plugs, magnetos and carburetters have kept pace to provide units of high efficiency and long life between overhauls.

The single-sleeve valve engine has proved itself under the arduous conditions of war-time operation, and the present range of sleeve-valve engines in units up to 2,000 horse power will be available to supplement a similar range of poppet valve engines.

Air cooling versus liquid cooling is still a controversial subject with good arguments on both sides. Whilst that bogey of the air cooling enthusiast, large frontal area, has been partially laid by the successful efforts in close cowling, the opposite bogey of the liquid cooling enthusiast, high radiator resistance, has been laid by the ducted radiator which reduces the drag to an almost negligible amount.

The power-to-weight ratio of engines has increased considerably, and although this is due partly to developments in metallurgy, the gradual stepping up of boost pressures with small structural change has shown that our earlier engines had a good deal of reserve strength.

Two-stage, two-speed, engine-driven superchargers with intercooling and automatic speed change with altitude, represent present-day supercharger development in this country, whilst the Americans have pursued the exhaust-driven turbo-supercharger and developed it very satisfactorily to an efficient unit.

The method of introducing fuel into the cylinders has undergone a change during the war years. Whilst we in Britain have concentrated on the jet type carburetter, the Americans have produced and are using on a high percentage of their engines, a device which injects a continuous, metered spray into the induction system between the throttle and the supercharger. The Germans, on the other hand, employ direct, timed injection of fuel into the individual cylinders of all their front line engines. Two main advantages of the injection method are freedom from icing and from vapour lock at altitude, but against these the greater number and complication of parts, particularly in the German system, means greater liability to breakdown, apart from high manufacturing and servicing costs. Development of injection systems will, of course, bring about some mechanical simplification and a high percentage of post-war engines will probably receive their fuel by continuous injection. There is still a commendable tendency towards securing reduced fire risk by the adoption of a safety fuel and since the carburetter cannot satisfactorily vaporize this fuel, it will have to be injected.

Maintenance of military aircraft is now simplified by the adoption of interchangeable power units which are designed to bolt directly to a bulkhead in the wing or fuselage structure, where special facilities are provided for the rapid connection of all the services.

Little has been seen of diesel aero-engine development in this country, but they offer advantages in elimination of fire risks and in reduced fuel consumption and will undoubtedly figure in post-war aeroplanes, although not immediately. Jet propulsion has made some strides and although it is not yet possible to discuss this fully, it is fair to assume that the application of diesel engines to this work will spur their development.

The petrol engine has reached such a high standard of development that no drastic alterations can be visualized. For post-war use, engine design will be based on the requirements of the individual aeroplane and like aeroplane design generally, will be directed to the solution of a specific problem. It is probable and desirable that different makers' engines of equal type and horse-power will be interchangeable to facilitate maintenance.

Progress in propeller design has kept pace with that of engines and constant-speed, feathering propellers, operated hydraulically or electrically are a normal part of the power installation. Four-bladed propellers for operation at high altitudes and contra-rotating propellers which eliminate torque and straighten the slip-stream, are further developments to which can now be added, reversible pitch propellers.

Other Developments

Other developments such as assisted take-off, high-altitude flying, radio aids to navigation and many more, too numerous even to mention here, give the designer and operator of post-war aeroplanes a very great wealth of data and experience to assist in the immediate application of aviation to the peace-time needs of the country.

We are not lacking here, but I feel that in spirit we are lagging behind our competitors and unless we rectify this at once, we shall be compelled to stagger along in converted bombers and borrowed, obsolescent aeroplanes.

Society of British Aircraft Constructors

SINCE the above article was written the Society of British Aircraft Constructors have issued a statement which urges among other things complete understanding with the dominions; state aid for aeronautical research; an inquiry into airport facilities; and provision for at least one super land and sea airport, preferably near London.

The Society envisages three main stages in the development of British transport aircraft immediately after the war: (*a*) the use of aircraft developed from Service counterparts but embodying the latest improvements; (*b*) bringing into service the types particularly suited to air lines; and (*c*) in about ten years time the use of aircraft embodying jet propulsion, full boundary layer control, and flying-wing design.

Other recommendations made in the report are: governmental decision on future ministerial control of civil aviation; provision of prototypes of new commercial aircraft; encouragement of schemes to provide a continuing supply of technicians; decision on the licensing of internal air services; and provision for full interchange of operational data.

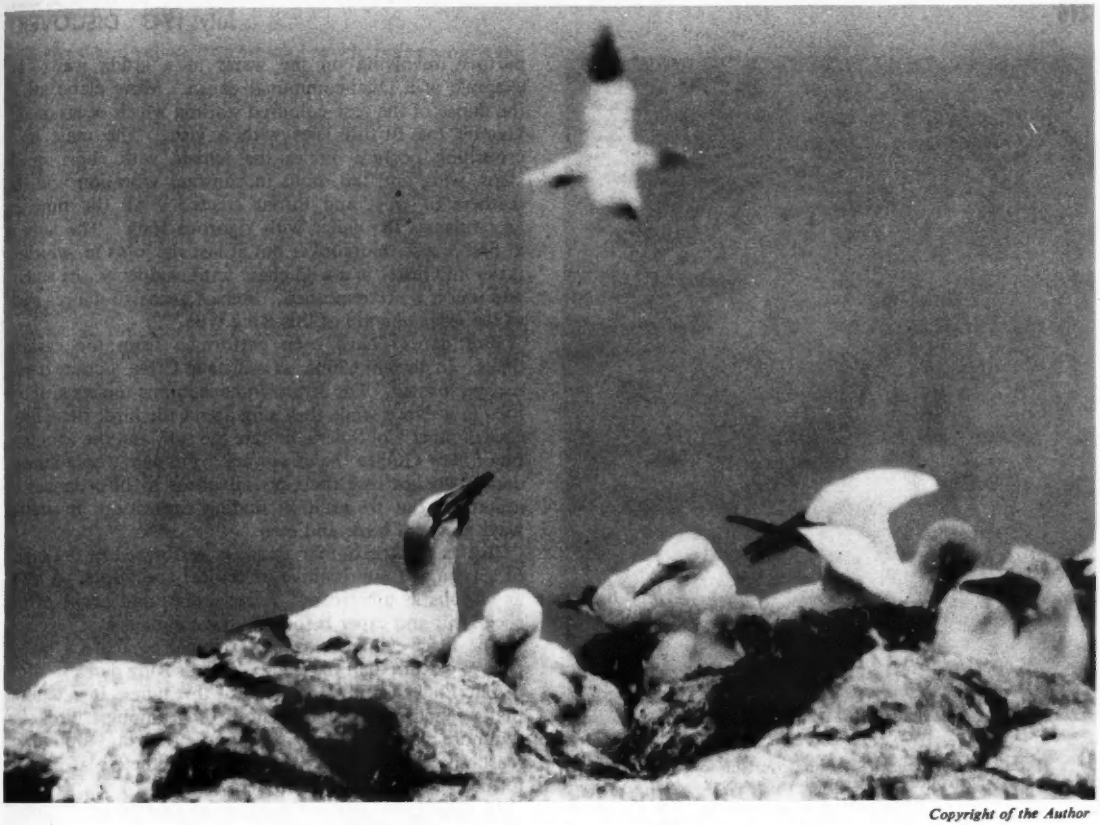


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FIG. 1.—Gannets. The left-hand gannet is swallowing particles from the nest—probably owing to nervousness; the bird on the right-hand is engaged in the bowing display.

Dances of Birds and Men

EDWARD A. ARMSTRONG

It is happily becoming less usual for naturalists to write of birds as if they were queer, rather inferior human beings, with desires and aspirations, fears and foresight, such as we find in ourselves. Birds are known to be very differently endowed mentally, and he who studies them has to be on constant guard lest he read his own ways of thinking, willing and desiring into their minds. This is so generally recognised amongst ornithologists that there is at present a tendency to react in the direction of the opposite extreme and to regard birds as mechanisms rather than as individuals. The truth, of course, lies mid-way between the two extremes. Although birds and men have very different intellectual capacities, they have a good deal in common emotionally. This can be proved by observing how they express their feelings in the dance.

No anthropologist studying the cultures of primitive peoples would neglect to investigate details of their dances, for they reveal a great deal both of the structure of society and the psychology of the individual. It is recorded of a native who was anxious to know what the people of another tribe were like, that he asked, "What do they dance?"—a very intelligent and penetrating question. Once we know what folk dance we possess a key by which we may decipher much of their mentality. If we can trace similarities between the patterns of human and avian dances, it will not be unreasonable to suspect that there exists some common emotional basis responsible for them.

Types of Dance

In actual fact almost every type of human dance has an opposite number amongst birds. Human dance motifs may be roughly classified as: Static, Line, Ring and Place-changing. In regard to numbers participating they may be: Solo, Dual, Dual-communal or Communal. Emotionally they may be: Excited (or Ecstatic), Erotic, Bellicose or Social. Various combinations of types from the different groups are possible. Nearly all these types have their parallels in bird life.

It is, of course, utterly impossible in a short article to

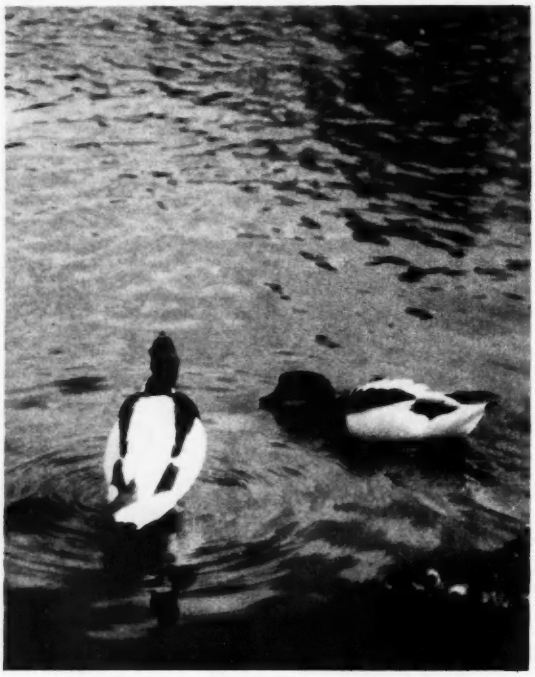

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FIG. 2.—Sheld-Ducks. During courtship one of the birds will strut or swim around with its neck held low.

give examples which will fully vindicate this statement, but we have only to spend a few days in spring on our seashores to discover bird dances which remind us either of the ballroom or of the savage festival.

Sheld-ducks have increased greatly in recent years so that it is not very difficult to find a spot where we may watch them. If we lie on the sand dunes and peep through the marram grass to the moist flats beyond we may see some such performance as this: The birds, which have been dabbling in the pools, preening and strolling around, form themselves into two irregular lines and advance towards each other. At first the pace is slow, but soon it quickens, and with wings arched, red bills open and uttering shrill squeals the drakes run forward to battle with their necks thrust forward like red-tipped couched lances. But all this sound and apparent fury signifies little, for the tournament is conducted in a most amicable spirit and no bird loses his temper. When a drake scores a hit on an opponent he throws up his head and neck and works it sinuously as if the lance had become a banner of triumph. In similar fashion the Caroline Islanders, having painted their legs and bodies red, advance in opposing rows brandishing spears, but there is no bloodshed.

Such is the Line dance as performed by birds and men; but sheld-ducks, like many others of their tribe, also dance a primitive Ring motif. One bird—often, I have observed, the female—potters round the other to an accompaniment of mingled grunts and squeaks. Shovelers may sometimes be seen in a paddling of thirty or more each with his partner, revolving on the water in a crude waltz—an example of a Dual-communal dance. More elaborate is the dance of the rose-coloured starling which occasionally favours the British Isles with a visit. The male in a crouching posture circles the female with short quick steps, wing and tail quills in constant vibration and the feathers of crest and throat erected. All the time he accompanies the dance with vigorous song. The lady is at first a passive onlooker but at last she joins in, whirling faster and faster in a wild chase until, suddenly, she squats and union is accomplished. Some Caucasian dances such as the *lezghinka* are of this Ring type.

Bird dances have been performed from the earliest times. In ancient China, as well as in Crete, a crane dance was performed. The Jivaro Indians mimic the cock of the rock in a dance while they sing about the bird; the Chukchee of Siberia of Siberia imitate the ruff; and the Monumbo of New Guinea the cassowary. But as a whole human dances do not owe their resemblances to bird dances to imitation, but to emotion finding expression in similar ways amongst birds and men.

Just as many a human dance is performed in the midst of a group of appreciative or critical spectators, so birds as various as albatrosses, geese, cranes and cocks of the rock strut and caper before an avian audience.

The Place-changing dance is typical of a much higher type of culture than the Static, Line or Ring dances. Most of our English folk dances are of this type. It is natural that we find only crude versions of it amongst birds, for the more elaborate forms presuppose a certain amount of reasoning and memory power. Nonetheless it is performed by a number of different species.

In spring the jolly little *black guillemots* or "tysties" return to favourite bays along the Irish and Scottish coasts, and all through the breeding season they frolic on the water, dancing and diving every forenoon. The dance, which I have described in detail in *Birds of the Grey Wind* consists of several figures. The birds spend much of their time in pairs on the water, one bird swimming around the other while a high-pitched cheeping note issues from their bright red inner mandibles. Both birds paddle so as to remain *vis-à-vis*, so that the effect is a kind of water-waltz. But frequently the playful couples approach one or two other pairs of dancers and then a different figure of the dance is executed. The dumpy birds separate a little and, suddenly, one of them dives. Hey, presto! all the others go under too, and the sea, so swiftly bereft of their animated presence, looks quite forlorn. But gazing beneath the surface you may see them swimming in pursuit of each other like great black-and-white butterflies in the bottle-green depths. When they emerge the chase may continue on the surface, but often, so excited are the birds, they fly up in pairs and speed around the bay. Sometimes the whole flotilla flies up together and circles the bay in a whirring pack. Then they alight and wheeze and sigh on the rocks. There is another dance figure which one sees occasionally. The birds—as many as ten—form into a line and sit thus on the water spaced almost equidistant from each other.

Another very different kind of Place-changing dance is that performed by Gould's manakin. When traversing the Panamanian forest I was sometimes mystified by loud snaps close at hand, as if some beast were on my trail. I was relieved to find that the sounds were made by the

little green and yellow bird which I saw hopping amidst the undergrowth. Each manakin makes a "court" by cleaning away every leaf and twig from the forest floor. Here he remains almost constantly in attendance. When the spirit moves him he jumps on the twigs above the court and leaps back and forth calling *chee-poo* and making a loud click with his enlarged wing quills. Whenever he spies a female approaching he begins this performance. Thus he induces her to join the dance, and the two birds leap back and forth in the court, crossing in the middle of their leap just as folk dancers "set to partners." Then the two birds disappear into the jungle.

Some of the manakin's antics might be classified as aerobatic dancing, for the bird will sometimes flutter almost upside down with beak to the ground in his court or balance with his bill on the tip of a twig like a moored dirigible. But our own snipe is hardly to be surpassed in aerobatics by any foreign species. It will turn over in mid-air and glide along upside-down.

Reciprocal Dances

A large number of birds perform dual, mutual, or reciprocal dances. It is a most entertaining experience to spend a few hours in a large gannetry watching the strange display of these birds. It is conducted, like many South Sea island dances, by gesture rather than by foot movements. Often it is performed solo, but in the complete display two birds take part. They stand close together facing each other and make sweeping salaams with their heads and necks repeatedly. Simultaneously the wings are spread and waved and the tail is raised and lowered. Associated with these obeisances amongst gannets is a ceremony which might be called "fencing" or "scissoring." The two birds stretch their beaks sky-wards, partially open their wings and waggle their heads energetically so that the bills clatter as in a kind of fencing, or scrape together as if they were being whetted one upon the other.

Of all dual dances none can be compared for strangeness with the frolics of red-throated divers. Not only will they scurry to and fro on the surface of a loch in an upright position like penguins, but they will even throw themselves upside down in the water as if they had been shot and with legs waving wildly swim just below the surface.

Less spectacular but more beautiful is the connubial ceremonial of whooper swans. The cob and pen swim to greet one another with beaks raised and wings uplifted while a hollow clangour sounds over the placid lake. The duet continues as the birds float side by side. Every time the male honks his mate replies immediately on a slightly lower note. Strangest of all is it to see them after the excitement has somewhat subsided, swimming together and moving their necks in various gestures, dipping them to the water or raising them in the air in such synchronized perfection that it is as if there was but one bird with a mirror alongside it.

A quaint reciprocal duet may be observed amongst king *penguins*. The birds have a very precise ritual. With great deliberation they draw themselves up to their full height, stretching their beaks straight upwards, then they bring their flippers smartly to the front and emit several strident trumpet notes. As soon as the last call has died away the

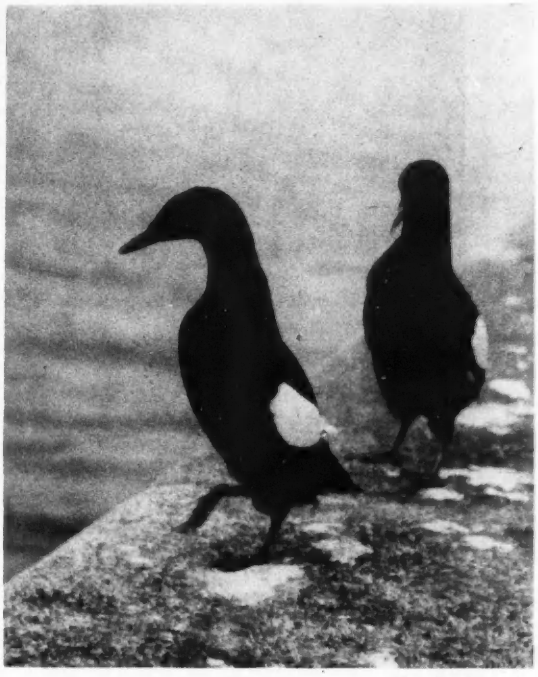

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FIG. 3.—Black Guillemots. In the intervals of their water-waltzes the birds alight on the rocks and chase each other. As they call they display the bright red interior of their mouths.

birds make a swift, profound bow, pausing obsequiously with the head low, and then resume their ordinary attitude. Two penguins sometimes stand close to each other and trumpet in turn, each politely waiting until the other has finished his bow before sounding his own horn. Adélie penguins hold their heads aloft in an ecstatic way and such posturing is so infectious that when one starts others quickly follow suit, until a vast concourse stand with their heads in the air.

Unquestionably birds readily imitate one another, and here we have a tendency which has contributed to the evolution of the social dance amongst birds as well as men. There is a mental derangement known as Arctic hysteria which shows itself in an irresistible desire to mimic other people. A company of Russian soldiers has been known to imitate their officer, each man reproducing his every gesture. His comments have not been recorded, but the incident helps us to understand how corporate ceremonies have arisen amongst birds through the contagiousness of imitation. It is frequently the case that as the numbers involved increase the more animated is the display and the longer its duration. This is true of the oyster-catchers' rather puzzling dances. As many as a dozen birds may take part but more commonly there are three participants. Two of them may pipe loudly while the third loiters close at hand, but at times the object of the music-making seems to be to pipe an intruder from the premises, for the two birds run shrilling around him in a way which obviously

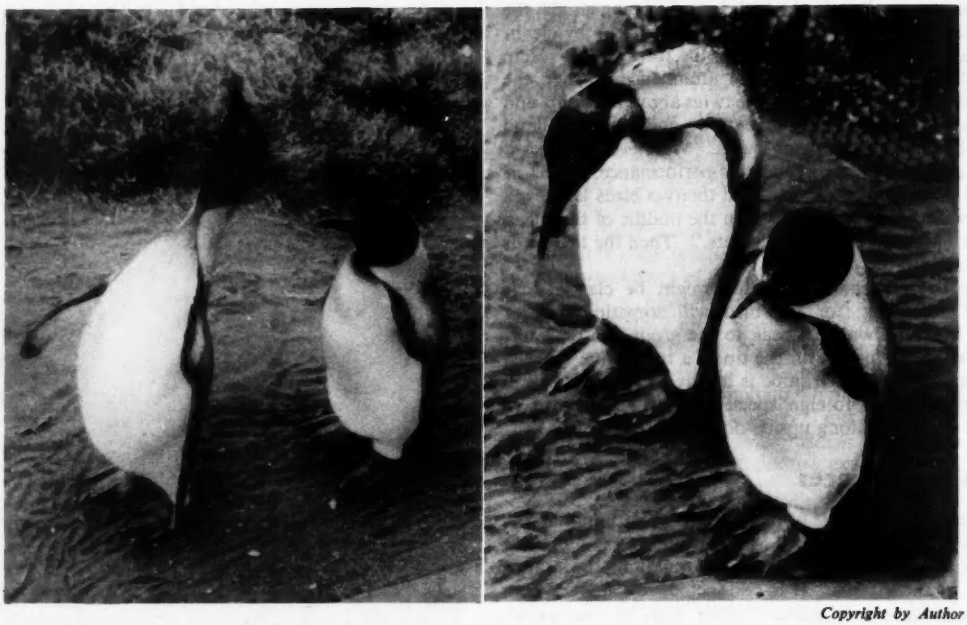

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FIG. 4.—King Penguin. Here on the left we see the first movement of the bow and on the right the completion of it. Sometimes one bird will bow regularly while its companion remains indifferent; on other occasions they bow to each other in turn.

suggests that his room would be more pleasant than his company. Sometimes a formal march ensues—a characteristic element in the dances of cranes, spur-winged lapwings, and many other birds. Two oyster-catchers walk silently in solemn procession for a hundred yards or more with heads bowed while the third brings up the rear, head in air, and piping volubly all the time.

Social dances have been wrought to such perfection by cranes of various species that nearly all those who describe them use the terminology of human dancing. An American observer compares the dance of the whooping cranes to a cotillion. Two birds stand apart making a strange cry in irregular rhythm while most of the others prance in a circle alternately raising and lowering their heads while keeping their wings uplifted. At the same time as the outer circle shuffles round, several birds in the centre dance counter clockwise, working themselves gradually to a slow frenzy. Sometimes the two musicians join the circle and two other birds take their place. English bird-lovers are not likely to see such an elaborate performance in their own countryside, although there are reports of herons being seen in a circle with one bird performing in the centre.

Display of the Great Snipe

There can be few more extraordinary sights in the whole realm of nature than the dance of the great snipe. At sunset the birds gather on the Swedish and Russian marshes, and stationing themselves in a long line start their strange song, which has been compared to "the song of a willow wren whilst a strong wind is sighing amongst the branches". The solo of low warbling notes is vocal, but the obbligato is created by a rapid quivering of the mandibles. As they sing they throw their heads backwards, almost upside-down, in the attitude of a stork beginning to "klapper" or a cormorant in the throes of courtship. The most singular aspect of the performance is, according to one observer, that the song begins at the end of the line and is taken up by bird after bird along it, ceasing in reverse order.

Were there space it would be possible to point out innumerable parallels between the emotional types of bird and human dances. The prairie grouse and the capercaillie go into such ecstasy during their display that the crafty coyote or stealthy hunter may creep upon them unawares. The peculiar, conventionalised war dance of the ruffs is well known. Erotic dances of solicitation are not uncommon. With many a wide yawn displaying the yellow mouth cavity the female cormorant postures to the male.

To discuss the meaning of bird dances would take us far beyond what is possible in this short survey, but we may be confident that it is not by accident that emotion is expressed according to similar patterns by the two kinds of bipeds we have been considering. There is a deep-seated emotional urge in common, and a tendency for it to manifest itself according to certain patterns of behaviour in specific dance figures. The study of animal psychology is still in its infancy, but we can expect that future investigators may be able to tell us more precisely why two orders of beings, so different in many respects, express themselves in ways which resemble each other. Without falling into the snare of anthropomorphism we may congratulate ourselves that some of our fellow-inhabitants of this lovely world are emotionally not entirely unlike ourselves.

[The relationship of bird and human dancing is discussed at some length in the author's *Bird Display* (C.U.P., 1942) in which three of the illustrations used in this article have already appeared.]

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Anti-Malaria Control Units at Work

FIG. 1.—*A stream is canalized to make the water flow more quickly. Underbrush is cut away and no stagnant pools along the sides of the stream are permitted to remain.* 2.—*Driver A. Kither, of Woolwich, taking samples of water from a suspected stream.* 3, 4, *and* 5.—*The water is sprayed with Paris Green to kill mosquito eggs which may be in it. Large ponds and other similar areas of water are treated with larger sprayers.* 6.—*Lieut. W. Browne, O.C. of one unit, examines mosquitoes in a test tube.* 7.—*An anti-malaria poster is posted up in a Tripoli hospital.*

When a new camp is established in Syria, the country for at least three miles around has to be cleared of malaria carrying mosquitoes and their breeding grounds. Special malaria control units have been formed to do this work. Their duty is to clear away undergrowth in and around ponds and rivers, to dig channels so that stagnant water will drain away, and to spray Paris Green on water in the area. These pictures show one of the units at work in the Tripoli area.

The Night Sky in August

M. DAVIDSON D.Sc., F.R.A.S.

The Moon.—New moon occurs on August 1d. 04h. 06m., U.T., and full moon on August 15d. 19h. 34m.

Conjunctions.—The following conjunctions will occur during the month:

August

2d. 15h.	Mercury in conjunction with the moon, Mercury 0°·5 N.				
4d. 08h.	Venus	„	„	Venus	7° S.
22d. 16h.	Mars	„	„	Mars	4° N.
24d. 18h.	Saturn	„	„	Saturn	3° N.
28d. 21h.	Jupiter	„	„	Jupiter	0°·9 N.

Occultations.—The following occultations of stars brighter than magnitude 6 will take place:

Aug.	12d. 21h. 38·9s.	121	B. Sgr	D
	20d. 23h. 09·4s.	ξ	Cet	R
	23d. 03h. 02·0s.	γ	Tau	D
	23d. 04h. 09·7s.			R
	23d. 12h. 36·8s.	α	Tau	D

The times refer to Greenwich and D and R imply disappearance and reappearance, respectively.

The Planets.—Mercury is an evening star and at the beginning of the month sets at 20h. 08m., shortly after sunset. The planet reaches its greatest eastern elongation on August 29 and sets at 19h. 23m. on that day.

Mars is in the constellation of Aries at the beginning of August and moves into Taurus early in the month. It can be seen as a morning star, rising at 23h. at the beginning of August and 1h. 10m. earlier at the end of the month.

Venus sets about 20h. 45m. at the beginning of the month and at 18h. 10m. at the end of the month. On August 13 the planet is stationary and sets at 19h. 50m.

Jupiter is too near the sun to be observed in the early part of the month. At the end of the month it sets at 18h., nearly an hour before sunset.

Saturn, in the constellation of Taurus, is a morning star, rising at 1h. and 23h. at the beginning and end of the month respectively.

The times of sunrise and sunset are given in the following table:

	Sunrise		Sunset
Aug.	1—4h. 21m.	..	19h. 50m.
	15—4h. 38m.	..	19h. 30m.
	31—5h. 09m.	..	18h. 51m.

The figures refer to the latitude of Greenwich.

In addition to the phenomena referred to the following will take place:

August 4h. 17m. Mercury in conjunction with Regulus, Mercury 0°·8 N.

17h. 07m. Mercury in conjunction with Venus, Mercury 6°·1 N.

Eclipses.—There will be an annular eclipse of the sun on August 1, invisible at Greenwich. It will be visible as a partial eclipse in Australia, and at Melbourne its magnitude will be 0·69. At this place it will commence at 4h. 02m. and end at 6h. 45m.

A partial eclipse of the moon will take place on August 15, and it will be partly visible at Greenwich. The beginning will be visible generally in the western part of the Pacific Ocean, Antarctica, Australia, New Zealand, the Indian Ocean, Asia, South-eastern Europe, and Africa, except the north-western part. The circumstances of the eclipse are given below.

Moon enters penumbra	Aug. 15d. 16h. 58·0m.
Moon enters umbra	15d. 57h. 58·5m.
Middle of eclipse	15d. 19h. 28·4m.
Moon leaves umbra	15d. 20h. 58·1m.
Moon leaves penumbra	15d. 21h. 58·3m.

Note on Eclipses

An annular eclipse (*annulus* a ring) can be illustrated very simply by using a disc of paper to represent the sun, light from a torch shining through the paper which should be thin. Hold a coin at such a distance from the eye that it does not cover the disc completely. (The experiment must be conducted in a dark room to be effective.) If the centres of the disc and coin and the eye are in a line, it will be noticed that there is a ring of light on the disc which is not cut off by the coin, and this represents the portion of the sun, like a ring, which is seen during an annular eclipse the inner portions being obscured by the intervening moon. The disc, coin and eye correspond to the sun, moon, and observer, respectively. If the eye is moved a little to one side, instead of a ring appearing, part of the disc will be seen and part will be in darkness, and this represents a partial eclipse. Obviously an annular eclipse at one place on the surface of the earth can appear as a partial eclipse at another place. If the eye is moved far enough, no portion of the disc will be invisible, showing that an eclipse of the sun is not seen everywhere on the earth. In some places it may appear partial or total but in other places no eclipse will be seen. A total eclipse of the sun at any spot on the earth's surface cannot last longer than 7½ minutes, but in most cases it is very much less than this.

An eclipse of the moon can be illustrated in the same way, but in this case a disc larger than the coin should be used to represent the earth, which is then between the sun and the moon. The illuminated disc will cast a shadow on the coin, but by a skilful adjustment of the distances of the coin and the non-illuminated disc, it will be easy to cast the shadow on a portion only of the coin, illustrating a partial eclipse of the moon. A lunar eclipse has very little scientific value in comparison with a total eclipse of the sun.

The Bookshelf

Foundations of Astronomy. By W. M. SMART, pp. 268, Longman's, 16/-.

First Steps in Astronomy. By P. F. BURNS, pp. 214, Ginn and Company, 5/-.

Guide to the Stars. By HECTOR MACPHERSON, pp. 135, 4 plates, Nelson, 6/-.

THE black-out has awakened the interest of the city dweller in the night sky which he rarely saw until now. The demands of the R.A.F. have brought to our universities many young men who must be given technical training, including astronomy. The Royal Observer Corps, the anti-aircraft gunners, and the Air Training Corps contain hundreds of people who are seeing the stars for the first time, and who, moreover, are eager for further information.

To meet this new interest many books are being written on popular astronomy at all levels, from that of the navigator in training to that of the air-raid warden who is only casually interested. For once the citizen is positively asking for a particular branch of science, and we must judge books produced in response to that request not only by the lucidity of their exposition, but by their fitness for purpose and suitability for the particular audience at which they are aimed.

In particular we must judge them by the degree to which they bring out the fact that astronomy grows by the application of scientific methods of investigation, and condemn where they seem likely to leave on this new type of audience the impression either that astronomy is a collection of dogmas, or a subject which is essentially pervaded with an air of mystery and theology. The treatise on popular astronomy fails if it does not give the reader a mental picture of the ordinary day-to-day scientific investigations with which the astronomer is concerned.

These three books are designed for very different audiences, and their success or failure is to be judged by their probable effects on those audiences. Professor Smart's *Foundations of Astronomy*, like its elder brother *Spherical Astronomy*, is a mathematician's book. It begins with a study of the properties of spheres, proceeds via spherical trigonometry, through the standard topics of positional astronomy to final sections on eclipses, stellar motions, and binary stars. There is no doubt that for the ordinary university student the book forms an admirable short compendium of the mathematical formulae and theoretical bases of positional astronomy. On the other hand it seems very doubtful whether the publishers' claim that this book will be of value to the "large numbers of our young men in the naval and air forces" is justified, unless the reading of this book is prefaced with very extensive instruction designed to show why such topics as spherical trigonometry are important to the practical navigator. There is always the danger that the practical enthusiasm of this new type of student will perish in the somewhat arid desert of mathematics unless the practical significance of the mathematics is demonstrated first.

Mr. Burns' *First Steps in Astronomy* is of a much more elementary character and would be of the greatest value to members of the A.T.C. and interested amateurs. There is far more emphasis on the *methods* by which knowledge has been attained, and there is a number of easy practical exercises which should bring home these points to the student. For the beginner, all too easily confused by the multitude of visible stars, such practical tips as the estimation of angles by the apparent size of the hand and fingers held at arm's length should be of special value. For its standard this is an excellent book, and the only criticism which it is possible to make is to deplore the reverence for tradition which led the author to embellish his constellation diagrams with the traditional pictures of birds and beasts. The vivid imagination of the ancients may have adorned Andromeda, Perseus and Cassiopeia with varied anatomical details, but we can hardly pretend that most of the constellation configurations even remotely suggest the objects they are supposed to represent. Is it too great a break from tradition to suggest that these personifications are of very little help to the student of the stars?

Dr. Macpherson's *Guide to the Stars* is largely concerned with straightforward description of the constellations and planets, and is a very readable little volume. It has diagrams of eighteen of the constellations giving star magnitudes, but the book might have gained if a map or two showing the relative situation of these constellations had been included. There are four plates of only moderate quality illustrating the sun, moon and planets, Comet Morehouse and two nebulae. It seems a pity that when such excellent astronomical photographs are available the author should have chosen drawings for his planetary illustrations. While few photographs can show as much detail as can be collected on a drawing incorporating all the features observed in many moments of good seeing, it cannot be said that the illustrations of Jupiter, Mars and Saturn are particularly convincing. In particular the drawing of Mars showing very well-developed canals is liable to give the inexperienced student an altogether too definite a belief in the reality of these elusive features. D.S.E.

The Beginning and End of the World. Riddell Memorial Lectures, Fourteenth Series, delivered before the University of Durham at King's College, Newcastle-upon-Tyne in February 1942. By Professor EDMUND TAYLOR WHITTAKER, F.R.S. (Oxford University Press, 1942, pp. 64, 2*s.* 6*d.*)

THE Trust Deed of the Riddell Lectures requires that the lectures should treat of the relation between religion and contemporary development of thought, and Prof. Whittaker has selected the subject of cosmogony, showing the significance for religion of the conclusions of men of science in the light of recent developments. The ancient Greek philosophers approached the problem of the cosmos with a decided theological interest. The doctrine of *atomism* had an important influence on the development of science, and it is true to say that Democritus was responsible for the first purely materialistic philosophy. In recent times certain physicists have also displayed a theological interest in the subject and have suggested a spiritual interpretation of the universe. Prof. Whittaker thinks that the subjective idealism which some have favoured is not likely to prevail; men of science will be more disposed to accept a dualism of a character similar to that of the Scholastics.

The three lectures supply a brief outline of the developments in modern science, especially in chemistry, physics, and cosmogony; and in the small compass of 64 pages the reader will obtain an excellent summary. On the other hand some may feel disappointed to find that the main object has not been fulfilled in a very satisfactory manner—to maintain the doctrine "That God, the first cause and the last end of all things, can, from created things, be known with certainty by the natural light of human reason." It is true that from the law of increasing entropy the author infers that the world was created in time and will ultimately die, and uses this as an argument against pantheism, for it is inconceivable that God, bound up with the world, should be born and perish with it. Beyond this argument (which involves metaphysical problems too numerous to deal with) there is no serious effort to uphold the main thesis, and it is surprising to find that with the modern cosmical outlook a man of science should commit himself to the following statement: "The goal of the entire process of evolution, the justification of creation, is the existence of personality; of all that is in the universe, this alone is final and has abiding significance." (p. 42.) The fallacy in this argument is that there is an *a priori* element—a presupposition of real knowledge of *values*. It is assumed that the self-conscious mind is higher and more valuable than the limited and largely instructive sentience of the copepod. Incidentally the argument also assumes that the universe is rational, but no proof is offered to show that the universe is rational in the sense that it forms a system of efficient causes. On the whole it cannot be said that cosmogony has rendered much assistance to religion, and it is doubtful if it ever will do so. Prof. Whittaker utters a profound truth when he says that "the doctrine of the Incarnation belongs to revelation." It might be added that the same remark applies to other doctrines.

M.D.

Far and Near

Sir Stafford Cripps on Research

In an address made last month to the Parliamentary and Scientific Committee, Sir Stafford Cripps, Minister of Aircraft Production, said he thought that in this country before the war research was often regarded as a rather extravagant frill to the industrial effort or, in some cases, a good advertisement for the commodity with which it was associated. If one compared the pre-war effort in this country to either the private enterprise research of the United States of America or to the Government-planned research of the Union of Socialist Soviet Republics, certainly we were at that period lagging very far behind. During the war we had improvised a very great volume of research mainly bearing upon the immediate problem of the war effort. Only we had had—owing to the shortage of personnel—to limit ourselves very strictly in our research programme to those matters which were likely to produce actual results in the field of war effort within the period that it was contemplated that the present war would last; even for the most pessimistic that period was a very short period when one was dealing with research. He still felt that we had not realized to the full the place that research must indeed take in relation to development and production, partly due to the view that we took of the status which was given to the research scientist. We gave him a position which was greatly inferior to that either of the administrator or of the production engineer or chemist, and as a result of that lower status, it was extremely difficult either to obtain or retain the very highly skilled and qualified staff which was necessary for the research effort.

Sir Stafford said that his colleagues in the various Supply Ministries were at the present time finding the greatest difficulty in getting a sufficient volume of personnel for research work. They naturally had to compete with the Services for the young scientists who were coming out of the universities, but even though they might get a very fair share of that volume, it was quite inadequate to carry out the research for the purposes for which they required it.

The State had long since taken over the major responsibility for the general planning of educational facilities, but it had not yet been decided as to how we were to plan and manage the whole range of basic and applied research that was necessary for the future of our industries.

In some of our industries, Sir Stafford said, there existed a dangerous habit of relying upon the research of other countries. In many cases before the war manufacturing firms in this country were relying on German or American research and were in fact merely exploiting foreign-owned patents and inventions in this market or the colonial markets. What was required was to increase the volume of our research both basic and applied and, at the same time, to introduce some measure of planning so as to make the best use of our available resources.

Sir Stafford suggested that it was time that we had a State Scientific Service apart from but on a parallel with our administrative Civil Service. He believed that such a service should be under the control of a single responsible minister so that he could draw together all the threads of scientific endeavour so far as the State was concerned. But the actual administration of the research itself should, he thought, be under a body of scientists similar, perhaps, to the Academy of Science in Soviet Russia, or to the Academia Sinica in China, and it should be their task to decide upon the classes of research institutes that required to be set up and also upon what broad lines the research should be carried out and planned, leaving a very large measure of local control to the actual head of the institute itself. It might possibly be that the Royal Society could perform that function if it had a special administrative staff for the purpose. It was most desirable that it should be left to scientists to decide these matters though, technically, their decisions would, of course, have to be in the form of advice because the Minister responsible for the expenditure would have to have the ultimate decision in order that he might be accountable to Parliament for the use that was made of the money. Such a development was nothing more than a natural growth out of the present rather muddled system as it existed. Sir Stafford felt that the moment had arrived for the introduction of a consolidating and amending bill (to use a parliamentary phrase) to deal with this whole question and to correlate it with the work of the universities and the industrial research institutions.

It was quite clear, therefore, that the amount of our effort pre-war was very much less than was needed and was much less than the other great industrial countries, including Germany. We must envisage spending at least 10 times as much after the war if we were to make headway or even to keep abreast in any of the industries such as the light chemical, optics, radio, civil aviation, as well as of the heavier industries.

Dr. Hill asked how it was proposed to raise the status of the scientific man which badly needed doing. How was it proposed to induce people to use the results of research and the knowledge that had been acquired? So often the application of knowledge lagged far behind.

Scientific Subscriptions and Income Tax

Mr. H. N. Linstead, Viscount Hinchingbrook, and Mr. R. Morgan last month tabled an amendment to the Finance Bill suggesting that the amounts not exceeding £15 a year paid by any person as subscriptions to institutions which (in the opinion of the Treasury) are conducted wholly or mainly for the advancement of any branch of learning, science or technology might be deducted from that person's emoluments for taxation assessment purposes. Mr. Linstead in the debate pointed out the existing anomaly that while professional scientists assessed under Schedule D were entitled to deduct for Income Tax purposes any such subscriptions, scientific employees assessed under Schedule E were not so privileged unless their employment was conditional upon their being members of such societies, and their employers were able to give a certificate to that effect. This weighed particularly heavily on young graduates receiving comparatively low salaries, he remarked; yet it would be these men who would be most likely to benefit from membership of the societies concerned.

In his reply, the Attorney-General rather burked the issue; he cited, in order to demonstrate the difficulties in distinguishing between allowable and non-allowable deductions, the decision of a learned judge who laid down that professional men could be allowed to deduct the cost of taking in professional literature from their taxable income. (This decision is debatable, as an allowance for "tools of trade" can be claimed by all classes of workers ranging from carpenters to journalists.) The Attorney General claimed that the real solution of the problem lay in ensuring that those who employ scientists should allot them salaries large enough to allow them to pay all the necessary subsctiptions.

Sir H. Williams asked the Attorney General what was the position of a company, from the taxation point of view, which paid the subscriptions of its employees to scientific institutions. The Attorney General was unable to give an explanation on this point.

In closing the debate, Mr. Linstead withdrew his motion, but commented that the Government spokesman had failed to explain why the difficulties that might arise if the concession were allowed to Schedule D taxpayers had never arisen in the case of Schedule E. He added "We shall have to plug away at this".

Industrial Fungi in India

A collection of type cultures of yeasts and fungi has now been established in India. The Board of Scientific and Industrial Research, which was set up two years ago to encourage industrial research, provided the necessary finance. By utilising the carefully selected organisms it should be possible for India to obtain by fermentation on the large scale a whole series of solvents, acids, esters, enzymes, vitamins, etc. The country, with its abundant resources of molasses and other raw materials, offers exceptionally favourable opportunities for providing supplies of such substances as ergosterol, which on irradiation with ultra violet light yields vitamin D.

Science in Adult Education

Science is not given its proper place in adult education, stated Dr. Elfed Thomas, director of education for Caernarvonshire, at an educational conference last

month. He suggested that greater use should be made in adult education of the laboratories and equipment to be found in the central and secondary schools.

Ultra Violet speeds hunt for Tungsten

AN ultra violet lamp, weighing only 1½ lb., is being used in Canada to track down deposits of scheelite (calcium tungstate), a valuable source tungsten. Scheelite fluoresces a characteristic bluish-white under ultra-violet light, although occasionally other minerals may be encountered which give almost exactly the same fluorescence. Using the lamp also makes it possible to arrive at a fairly close approximation to the percentage of WO_3 in a particular scheelite deposit. In Australia, too, the method is being exploited in order to increase supplies of this mineral. The technique is considered so handy that it is being applied in all mines where the regional geology suggests the remotest chance of scheelite occurring. It is of interest to note that a mine face can easily be photographed in ultra violet light, providing a permanent record of the fluorescent areas which can be measured on the photograph by planimetric methods so enabling the grade of the deposit to be determined above ground afterwards.

Penicillin now has two committees

A SECOND committee has been appointed to deal with penicillin. The setting up of a committee by the Ministry of Supply to ensure that everything is done to promote the most rapid development of penicillin production was reported in *Discovery*, May 1943. The new committee, known as the Penicillin Clinical Trials Committee, has been established by the Medical Research Council. Its membership was given by the Lord President of the Council in the House of Commons last month as follows: Prof. H. R. Dean (chairman), Dr. A. N. Drury, Prof. A. Fleming, Prof. H. W. Florey, Dr. Percival Hartley, Mr. R. Vaughan Hudson, Dr. C. N. Scott, Dr. J. W. Trevan, R. V. Christie (secretary) and Prof. L. P. Garrod (assistant secretary). In answer to a question from Major Lyons, the Lord President said that the new committee has to organise and supervise clinical trials, whereas the Ministry of Supply committee dealing with penicillin is primarily concerned with production although it has to take clinical requirements into account; there is a considerable ground of common interest between the two committees, he added.

Sir A. Southby asked whether the Lord President was satisfied with the attempts now being made to manufacture this invaluable preparation, to which the reply was "Yes, Sir. Very active steps are being taken." To Commander Locker-Lampson, who asked whether penicillin had proved its value, he replied "I think that has been established."

Anti-diabetic Plant Drug?

THE discovery of a plant drug with anti-diabetic properties is claimed by M. C. Nath of the Physiological Section of Dacca University on *Science and Culture*, April 1943, p. 427. He says that the drug, isolated from *Scoparia dulcis Linn.*, when used in doses of about 5 mgms. per day, not only relieves the symptoms of glycosuria (condition in which sugar is excreted in the urine) but can also on prolonged use for days and weeks together reduces hyperglycemia and brings the percentage of blood sugar to the normal limit. As the compound appears to be the specific remedy for diabetes mellitus, the author has introduced the term "Amellin" to describe the new drug. Research is continuing in order to find out the active principle responsible for its properties.

Tyres like Camels' Feet

A FACTOR in the rapid advances our Armies made in the African Deserts was a new type of tyre tread designed to simulate the foot action of the camel. According to the British *Rubber Age*, when it was realized that mechanical transport would require a special type of tyre to operate off the few roads built by the Italians, Mr. Hardeman, of the Product Design Division of the Dunlop Co., designed the new tyre from data obtained by the construction of models tried out on fine sand and the tread that was developed was based upon the same principle as the camel's foot. An example of very fine, soft dry sand, which tended to act like a quicksand, is provided in the Quattara Depression, where it was found extremely difficult to re-start stationary vehicles owing to the fact that there was no hard surface at any depth, or at any time of the day, upon which ordinary tyres could obtain a grip. Yet the "camel foot" tyres allowed vehicles to stop and re-start on such loose surfaces. These tyres were fitted to many types of vehicles including tractors, ambulances, water carts and general transport lorries ranging from 13 cwt. to 3 tons.

Coloured Machinery in the Production Drive

EXPERIMENTS have proved that a three-dimensional effect, with stereoscopic clarity, can be obtained by using medium grey, or green, for the body of machines, a light buff for the tooling area, and by an improvement of the general lighting of the surrounding area. The reflection from the light-coloured areas helps the operative to keep his attention concentrated on the working area, and so assists production.

America adopts a Tea Substitute

DALMATION sage (*Salvia officinalis*) has been adopted in America as a substitute for tea. Brewed like ordinary tea, it has a pleasing taste and therapeutic value, although unlike real tea it contains no caffeine. Sage tea is not a new beverage however; it has been used for years in the Balkan countries, rural America and China.

Zoo Aquarium re-opens

THE freshwater aquarium of the London Zoological Society has now been re-opened.

Quinine to be grown in America

ONE of the most remarkable stories of the fall of the Philippine Islands was that of Col. Arthur F. Fischer, who escaped with two million cinchona seeds he had managed to collect together. Now, under an arrangement with Costa Rica, up to 10,000 acres are to be devoted to the development of cinchona plantations in the Western Hemisphere, using seed which Col. Fischer saved.

A Physical Technique of Water-proofing

IN his 1943 Mather lecture to the annual general meeting of the Textile Institute, Sir Robert Pickard referred to a new self-sealing cloth developed during the war by his colleague at the Shirley Institute, Dr. Pierce, who realized that cotton fibre incorporated in a fabric in a condition in which it would swell with moisture would block up the interstices of the cloth and so make it water-holding without any water-proofing whatever. "Dr. Pierce seems to have succeeded in making a hose pipe on that principle by taking a long strong cotton, spinning it with a very low twist, weaving it closely, and relying on the physical characteristics of the cotton to swell with moisture in order to make a hose pipe which will stand up to the Home Office tests, which are very stringent in the way of water-penetrating pressure. Dr. Pierce is to follow on with water-holding canvasses, and he has now made water-proof garment cloths without rubber and without practically any proofing at all," added Sir Robert.

Plea for increased Forestry Research

THE encouragement of forestry research in Britain is advocated in the report on "Post-War Forest Policy" by the H.M. Forestry Commissioners (H.M.S.O. 2*s*.) The report itself makes depressing reading, for one finds that the expenditure of the Forestry Commission on research during recent years has averaged no more than the niggardly total of £15,900 a year, of which little more than 50% went to scientific staff. The commissioners now outline a policy of research to cost £300,000 in the first decade of the post-war period.

An equally ambitious report was published in 1920, when it was recommended thst sufficient funds be provided to enable the commissioners to finance the research advocated in that report. The 1943 report mentions that, while an advisory committee was appointed in 1930, no increase was made in the Forestry Commission grant for research purposes, and the research financed by the Commission has necessarily had to be of an *ad hoc* nature "to solve—if possible—problems of practical importance".

The reports recommend the setting up of a central forestry research station, and the State forest of Alice Holt, Hants, is suggested as a suitable site, providing a range of soils and species of trees, both soft and hard woods.

Personal Notes

DR. W. G. OGG, director of the Macaulay Institute for Soil Research, Aberdeen, since 1930, has been appointed successor to Sir John Russell as director of the Rothamsted Experimental Station, on the

latter's retirement at the end of September. Dr. Ogg, who is 51, has studied soils in various parts of Europe, America, Africa and India, and was the British representative on the Committee for the First Soil Map of Europe. He was educated at Aberdeen University and at Cambridge. During the last war he was chief chemist at an explosive factory, and later became advisory officer on soils at the Edinburgh and East of Scotland College of Agriculture.

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H. G. WELLS has submitted a thesis for the D.Sc. degree of London University. Mr. Wells gained his B.Sc. as a student of the Normal School of Science (now the Royal College of Science).

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DR. ISAIAH BOWMAN, president of John Hopkins University, has been elected president of the American Association for the Advancement of Science in succession to Dr. Arthur H. Compton of the University of Chicago.

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PROF. V. M. GOLDSCHMIDT and PROF. B. A. HOUSSAY have been elected foreign members of the Royal Society. The former is the Norwegian scientist who founded important schools of geochemistry at Göttingen and Oslo. Prof. Houssay has held the chair of physiology at the University of Beunos Aires since 1919, and is an authority on endocrine glands.

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PROF. E. J. SALISBURY, Quain professor of botany in University College, London, has been appointed director of the Royal Botanic Gardens, Kew, an appointment which has not been filled since November 1941, when Sir Arthur Hill was killed in a riding accident. Acting director in the interim period has been Sir Geoffrey Evans.

Nazis execute German Scientist

KURT HUBER, professor of experimental psychology in the University of Munich, has been executed by the Nazis. The official excuse is that he has taken part in "traitorous conspiracy". Reports in German newspapers state that Prof. Huber, who had been a professor at Munich since 1926, was arrested with his wife when distributing leaflets. He told the local Gauleiter, before whom he was brought, that the youth of Germany and the soul of the people were being endangered. The Gauleiter is said to have described the professor as "the intellectual leader" of a group numbering ten to twenty who printed and distributed leaflets exhorting the population to commit acts of sabotage amongst the armaments industry.

Charcoal for R.A.F. Parachutes

R.A.F. parachutes are now being made from a synthetic silk obtained from ordinary wood-charcoal. The war with Japan has cut short our supplies of pure silk and in any case the demand has exceeded the supply. Consequently an alternative source had to be found. The silk, of which there are sixty-four yards in each parachute, has to be strong enough to bear a breaking strain of 400 pounds. This synthetic was found to be equal to the task and is now almost universally used. Even though most used parachutes can be dried and refolded for further use, there is an ever-increasing demand now our air forces are rapidly growing and also for the use of airborne troops. This demand has indirectly created a boom in the rural industry of charcoal-burning, such as it has never been known in its centuries long history. Much wood charcoal is being made by the ancient method of slow combustion of such woods as oak, ash or elm in a covered heap, but in areas where the Ministry of Supply has cleared large tracts of woodland for home-grown timber, they have introduced a more modern method. This employs large dustbin-shaped kilns fitted with chimneys in place of the less economical heaps, and the lumps of charcoal are shovelled out of a kind of grate at the side of the retort. One of these methods of extracting wood charcoal from timber is being carried on in nearly every place of suitable woodland in the country—the revival of an ancient craft by the help of modern science to supply the newest defenders of our soil.

Poisoned Wheat

WHAT is probably the largest case of plant poisoning in the country, through the presence in the soil of toxic material, has taken place on Park Farm, Black Notley, Essex. Two well-drained fields of winter wheat, making little root development within localised areas, subsequently died off. Altogether about 14 acres were affected. The bad spots were ploughed out and, after liberal manuring, re-sown with spring wheat, which also failed. A detailed soil analysis revealed the presence of zinc, copper and chromium, with zinc predominating, and this element may have caused the trouble.

How the poisons got into the soil is not certain, but it has been suggested that, during some earlier tenancy, "sweeping" or "sludge" from a foundry may have been put on the land. In these times of fertilizer shortage, with the exception of waste lime approved by the lime officer, farmers would be wise to obtain expert advice before applying any unusual industrial waste to their fields. Had it not been for the ploughing campaign this poisoning would not have been brought to light, for the fields were originally very indifferent grass and used merely as outruns for poultry.

The Diet of Nestlings

A SOVIET science film which has arrived in this country shows a novel method of studying the diet of nestling birds. After the parent bird has nested in a nesting box and the eggs have hatched the fledglings are taken out and replaced by a model bird—an "artificial nestling". The apparatus includes a make and break contact which actuates an electro-magnet when the parent bird alights on the perch, and so opens the beak of the "artificial nestling" at the right moment. The mother bird inserts the food into the open beak, whence it falls into a collecting jar containing some preservative such as formalin. At the end of each day the contents of the jar can be taken out and analysed. When the method was used with starlings Russian children (the method is particularly suitable for nature study in schools) found that the bulk of the nestling's food consisted of insects injurious to farm crops.

It is interesting to note that there have been few scientific accounts of the kind of food given to nestling birds. One of the best reports was published by Robert Newstead in a supplement to the journal of the Ministry of Agriculture (then the Board of Agriculture) in December 1908. He then wrote: "The food of the nestling young is a phase of the subject which has received but little attention. It is my impression however that with more extended observations we shall find that not only are the young of the various species of insectivorous birds fed upon soft-bodied insects, especially caterpillars, but that the same kind of food is carried to the young of many of the finches and other hard-billed birds, which in their adult stages subsist very largely on a seed and grain diet.

Newstead's observations on the starling showed that out of 273 insects fed to nestlings, 269 belonged to the injurious group. The Russian experiments confirm these figures.

Discoverer of Human Blood Groups

DR. K. LANDSTEINER, the eminent pathologist who was awarded the Nobel Prize for Medicine in 1930 for his discovery of human blood groups, died in New York on June 26, states the Associated Press.

Thirty years of laboratory work enabled him to classify human blood in four main groups and more than 30 sub-groups. The discovery eliminated the fears that accompanied the earlier blood-transfusions and saved the lives of scores of thousands of wounded or anaemic persons throughout the world. His work, too, resulted in establishing blood tests as evidence of paternity, and courts in many European countries as well as in several States in the United States admitted such tests as competent to show at least a negative result in the cases of disputed parentage. He also had to his credit experiments which benefited sufferers from infantile paralysis.

Karl Landsteiner was born in Vienna on June 14, 1868. He received his medical training at Vienna University, and in 1909 was appointed Professor of Pathological Anatomy in the University, where he remained until 1919. Later he went to the United States, and joined the Rockfeller Institute for Medical Research in 1922. He was D.Sc. of Harvard, and in 1934 the honorary degree of Sc.D. was conferred upon him by Cambridge University, when he was acclaimed as a signal example of distinction gained in foreign lands. "Like Evander and other illustrious emigrants he accepted the decrees of heaven and adorned an adopted land."

In 1916 he married Helene Wlasto, of Vienna, and had a son.

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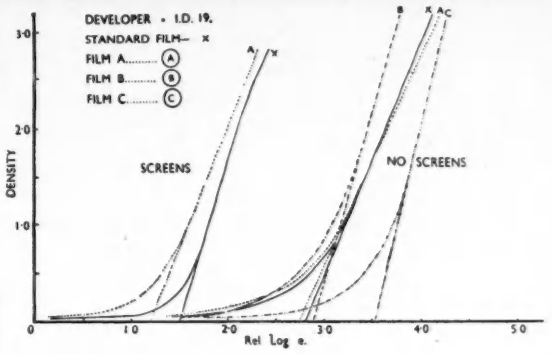

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Aspects of an Industry

CONQUEST OF PAIN

IT may at first seem a far cry from the chemical factory to the hospital operating theatre. Here is a modern surgical operation in progress. The picture was painted in an operating theatre at St. Mary's Hospital, London. The chief interest in it must naturally centre in the figures of the surgeon and the patient, whose form is no more than suggested on the operating table. Yet it is appropriate that the anæsthetist with his trolley should occupy such a prominent place, for surgery as it is known today dates from the discovery of practical methods of anæsthesia. The power to produce insensibility to pain has enabled the surgeon to achieve his miracles. Less than 100 years ago surgery was a dire last resort and a brutal business, the patient having either to be tied down or drugged with quantities of alcohol. In 1846 ether was used as a surgical anæsthetic by Dr. Warren in the U.S.A. In the following year chloroform was used in Edinburgh by Dr. (later, Sir James) Simpson, who was denounced from the pulpit for interfering with the works of God ! To-day anæsthesia is a highly specialised branch of medicine, employing a large and constantly increasing number of chemicals. Of these some are inhaled through a mask, some are injected into a vein, and some are infiltrated into the tissues. Some give complete anæsthesia, others varying degrees of local anæsthesia only. Ether and chloroform are still used, but modern chemical research has made available special anæsthetics for all purposes. Some anæsthetics are derived from the normal products of chemical factories. Ether is made from sulphuric acid and alcohol, and chloroform from bleaching powder and alcohol or acetone : cyclopropane and trichlorethylene are also relatively simple substances and are easily made, though skill and experience are necessary to produce all these in a high state of purity. Other anæsthetics, such as those of the barbituric acid group, are far more complex and their manufacture is made possible by the skill, resource and research of the British organic chemist. In the field of anæsthetics, British chemical factories and research laboratories stand behind the faculty of medicine to make available better and safer chemicals for the conquest of pain.

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Imperial Chemical Industries Limited, London, S.W.1

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